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**REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
SAMPLING AND ANALYSIS PLAN**

**LENZ OIL SERVICE, INC.
LEMONT, ILLINOIS**

REVISION: 3

**SUBMITTED BY:
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1.0 INTRODUCTION TO SAMPLING AND ANALYSIS PLAN

The Sampling and Analysis Plan (SAP) guides all field work by defining the sampling and data-gathering methods to be used and the physical and chemical analyses which will be performed. The SAP was developed in conformance with the USEPA draft document, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (RI/FS Guidance) dated October 1988. Guidelines for the selection and definition of field methods, sampling procedures, and custody were based on the USEPA document "Compendium of Superfund Field Operations Methods" (Compendium), dated December 1987. Data quality objectives (DQOs) were developed in accordance with the USEPA publication "Data Quality Objectives for Remedial Response Activities (DQO Guidance)", dated March 1987.

2.0 SAMPLING OBJECTIVES

Data collected during the Lenz Oil RI/FS must be of sufficient quality and quantity to provide an acceptable level of confidence in decision making and must address the following project objectives:

- o Determine the presence/absence and type of contaminants remaining in the on-site soil and the presence/absence and types of contaminants along the potential migration pathways, including ground water and surface water/sediment.
- o Determine the mechanism of contaminant release to the various pathways.
- o Determine the direction of transport pathway(s).
- o Determine the horizontal/vertical boundaries of source(s) and pathways of contamination, if any.
- o Determine routes of exposure and potential environmental and public health threats.

The primary uses for data collected during the Lenz Oil RI/FS will be for site characterization, risk assessment, and evaluation of remedial alternatives; however, health and safety and engineering design uses are also anticipated. The priority of data uses,

beyond those health and safety data used to establish level of protection, are for site characterization, risk assessment, and the evaluation of remedial alternatives. These data uses will require the highest level of confidence. Therefore, sampling and analytical procedures with low limits of uncertainty will be required.

Based on these intended data uses, the type of samples to be collected and the physical and chemical characteristics to be analyzed have been selected. The following types of samples will be collected: surface and subsurface soil, soil gas, sediment, surface water, ground water, and QA/QC samples. Each of these sample types will be analyzed for one or more of the following: TCL volatile organic compounds, TCL semivolatile organic compounds, TCL PCBs/pesticides, TAL metals, TAL cyanide, and TCLP metals. Physical characteristics to be measured include: (1) the pH, specific conductivity, temperature, and qualitative description of all surface water and ground water samples; (2) a qualitative description and a semiquantitative organic vapor concentration of all on-site soil samples; (3) a qualitative description and a qualitative organic vapor concentration of all off-site soil and sediment samples; (4) a qualitative organic vapor concentration from all soil gas samples; and (5) the particle size, total porosity, total organic carbon content, water level, and hydraulic conductivity of the aquifer materials.

3.0 SAMPLE LOCATIONS AND FREQUENCY

A summary of sample types and frequency proposed to complete the objectives of the Lenz Oil RI/FS is presented in Tables 3-1 and 3-2 and described below.

3.1 Ground Water Sampling

A total of 15 new monitoring wells (seven 2-well clusters and one deep replacement well) will be installed at the Lenz Oil Site at the locations shown on Figure 3-1. These wells will supplement the existing monitoring well network, which consists of one 3-well cluster and four 2-well clusters (Figure 3-1). The well cluster at G-105 has been damaged and will be abandoned as part of this project. The deep well in the G-106 cluster was previously filled with grout and will be replaced during this investigation.

The purpose of the proposed monitoring well network is to determine the magnitude and extent of ground water contamination, if any, emanating from the Lenz Oil Site. Well cluster G-101 is located upgradient of the site and will be the source of background ground water quality data. Well clusters G-104, G-106, MW-04, and MW-05 are located near, but downgradient of the probable contaminant source area, for the purpose of documenting the magnitude of ground water contamination, if any, near the source area. Well clusters G-102, MW01, MW02, MW03, MW-06, and MW-07 are located downgradient of the probable source area, near the margin of the contaminant plume, to determine the lateral extent and fate of ground water contamination, if any. The initial locations of the monitoring well clusters were selected based on previous ground water flow direction maps and ground water contamination data (see Section 2.0

of the Work Plan). Final well locations will be selected after the soil gas investigation and bedrock fracture analysis are completed and several rounds of water level elevations have been collected. These data will help locate monitoring (1) well clusters MW-05 and MW-04 in areas most likely to be contaminated, (2) well clusters MW-01, MW-02, MW-03, MW-06, and MW-07 near the downgradient and lateral margins of the suspected contaminant plume and (3) wells along major fractures that may serve as conduits for ground water flow.

A shallow (i.e., water table) monitoring well and a deep (i.e., approximately 30 feet below the water table) monitoring well will be installed at each new well cluster location to determine the vertical extent of ground water contamination. The final depth of the deep monitoring wells will be adjusted in the field so that the screened interval straddles significant water-bearing fractures.

One round of ground water samples will be collected from the 23 operational monitoring wells shown on Figure 3-1, including:

- o 15 new monitoring wells [MW01 through MW07 (shallow and deep wells) and the deep replacement well at location G106]; and
- o 8 existing wells [G-101 (3-well cluster), G102 and G104 (two 2-well clusters), and G106S],

This round of ground water samples will be analyzed for TCL volatile organics, TCL semivolatile organics, TCL PCBs/pesticides, TAL dissolved metals, TAL total metals, and TAL cyanide. The ground water samples will be analyzed for TAL total metals to

determine the potential contribution of solids to ground water contamination. The pH, specific conductivity, temperature, visual appearance, and qualitative (HNu) organic vapor concentration of each ground water sample will also be noted.

Geotechnical samples will be collected from saturated soil encountered during monitoring well installation. These samples will be collected from locations where a significant portion (greater than 2 feet) of the shallow aquifer is composed of unconsolidated soil rather than bedrock. Soil samples for geotechnical testing will be collected from all of the major soil types encountered in the aquifer and from locations distributed across the site. Total porosity, particle size and total organic carbon analyses will be conducted on these samples (Table 3-2). The rationale for collecting these data is to better define the hydraulic conductivity, mean flow velocity and contaminant retardation capacity of the shallow aquifer.

The monitoring wells will be tested to determine the aquifer's hydraulic conductivity via rising head permeability tests. Water levels will be measured in all monitoring wells on a monthly basis to identify the ground water flow direction.

Additional monitoring wells will be installed, and a second round of ground water samples will be collected if the magnitude and extent of ground water contamination has not been sufficiently defined by the data from the first round of ground water samples or if the data are not sufficient to support a Risk Assessment and evaluate remedial alternatives. The purpose of a second round of ground water samples would be to provide additional data needed to support the Risk Assessment and/or evaluate remedial alternatives.

The scope of a second round of ground water sampling (i.e., the number and locations of monitoring wells to be sampled and the analytical parameters to be measured) will be based on identified data gaps and will be described in an addendum Work Plan, Quality Assurance Project Plan (QAPP), and SAP, as necessary.

3.2 On-Site Soil Sampling

The on-site soil investigation was designed by IEPA to: (1) determine the magnitude and extent of soil contamination remaining at the Lenz Oil Site after the expedited remedial activities, (2) document the quality of the incinerated ash used for backfill and confirm that it meets treatment standards, and (3) indirectly assess the integrity of the visqueen liner placed in the main excavation area by determining whether the backfill above the liner has been recontaminated by ground water. These objectives will be accomplished by drilling and continuously sampling 23 soil borings and collecting a minimum of 57 analytical soil samples (Table 3-1 and 3-3 and Figure 3-2).

3.2.1 Magnitude and Extent of Contamination

The magnitude and extent of soil contamination remaining at the site will be assessed with a combination of random and directed soil sampling. Borings SB01, SB03, SB14, SB15, SB16, SB19, SB20, SB21, SB22, and SB23 have been randomly located around the perimeter of the main excavation area in the vicinity of the former Lenz Oil Service operations to assess whether or not the previous remediation efforts were sufficient. Borings SB02, SB13, SB17, and SB18 are also designed to evaluate the magnitude and extent of soil contamination outside of the main excavation area, but these boring

locations are directed to specific areas of potential contamination (i.e., SB02 is near stained soil identified in an aerial photograph and borings SB13, SB17, and SB18 are located in the former surface impoundment area). All of these borings will be drilled and sampled to bedrock. Soil will be continuously sampled and screened for the presence of volatile organic compounds by using an HNu. The magnitude of soil contamination encountered in each boring will be assessed by submitting soil exhibiting the highest HNu readings for analysis of TCL volatile organics, TCL semivolatile organics, TCL PCB/pesticides, TAL metals, and TAL cyanide. The vertical extent of soil contamination will be evaluated by collecting analytical samples from soil exhibiting the highest HNu reading at shallow depths (i.e., less than 5 feet), intermediate depths (i.e., 5 to 9 feet), and deep depths (9 feet to bedrock) at borings SB13 through SB23. See Table 3-3. Because bedrock is shallow in the western portion of the site, only two analytical samples (i.e., one from 0 to 5 feet and one from 5 feet to bedrock) will be collected from borings SB01, SB02, and SB03 (Table 3-3).

3.2.2 Quality of Incinerated Ash

The quality of the incinerated ash used for backfill in the main excavation area will be assessed by analyzing random soil samples collected from borings drilled on a 100-foot grid (Figure 3-2). Because the backfill is only 9 to 11 feet thick, and the lower portion of the backfill may have been recontaminated by ground water, samples designed to assess the original quality of the incinerated ash will be collected from shallow depths (less than 5 feet). Specifically, samples will be collected from the 0 to 2.5-foot interval in borings SB04, SB08, SB10, and SB11 and from the 2.5 to 5.0-foot interval in borings SB04 through SB12 (Table 3-3).

Analytical samples will be collected from the 2.5 to 5.0-foot interval in all of the main excavation area borings because this interval is most likely to have remained undisturbed since the placement of the backfill. The analytical results of samples from the 2.5- to 5.0-foot interval can be used to assess the original quality of the backfill (i.e., to determine if the sampled material was a hazardous waste when it was deposited). The shallow (0 to 2.5 foot) samples were randomly selected to determine the degree of vertical homogeneity of the backfill.

All of the samples collected in the main excavation area (SB04, SB08, SB10, and SB11 at the 0- to 2.5-foot interval and SB04 through SB12 at the 2.5- to 5.0-foot interval) will be analyzed for TCLP metals, TAL metals, and TAL cyanide to assess the quality of the ash. No organic analyses are proposed for these samples because organic contamination in the incinerated ash would have been destroyed at the temperatures that incinerators normally operate (1,800 to 2,200°F) and because the ash sampled is too shallow to have been recontaminated by ground water. TCLP is being run to determine whether or not the ash conformed to treatment standards.

3.2.3 Integrity of the Visqueen Liner

The integrity of the visqueen liner will be assessed by collecting analytical samples from backfill slightly above the liner. Samples will be collected from the 2.5-foot interval exhibiting the highest HNu reading between a depth of 5 and 9 feet in borings SB05, SB06, SB07, SB09, and SB12 (Table 3-3 and Figure 3-2). These sample locations are randomly distributed across the main excavation area. The samples will be analyzed for TCL volatile organics, TCL

semivolatile organics, TCL PCBs/pesticides, TAL metals, TAL cyanide, and TCLP metals. The purpose of these analyses is to determine whether or not the incinerated ash has been recontaminated by ground water, with the implication that the integrity of the liner has probably been compromised if the backfill is contaminated. According to Janssen (1990), the synthetic liner was placed directly on the underlying bedrock and there is no contaminated soil below the liner to sample. Samples will not be collected below a depth of 9 feet to avoid puncturing the liner.

3.2.4 Alternative Sampling Depths

If HNu screening does not register a reading above background, or all the soil from a designated sampling zone shows the same HNu readings, default sampling depths have been established. Samples representing the proposed depth intervals will be collected as follows:

- o 0-5 feet depth from the 2-5- to 5.0-foot interval,
- o 5-9 feet depth from the 7- to 9-foot interval, and
- o 5 feet to bedrock and 9 feet to bedrock depths from the 2.5-foot interval immediately above bedrock.

These default depths are designed to evaluate the maximum vertical extent of soil contamination to ensure that the extent of soil

contamination will not be underestimated. Because the HNu only has the potential to screen for volatile organics, and it has a relatively high detection limit compared to laboratory analyses, soil exhibiting no HNu reading may be contaminated and, therefore, will be sampled. The HNu screening is not meant to define the extent of contamination, but rather to direct the investigator to soil having a higher probability of containing elevated concentrations of volatile organics.

3.3 Sediment and Off-Site Soil Sampling

Sediment and surface soil samples will be collected along the drainage ditch northwest of the Lenz Oil Site to evaluate potential releases of contamination to the drainage system. Six sediment samples and 12 surface soil samples will be collected for analysis of TCL organics, TAL total metals and TAL cyanide (Table 3-2). The sediment samples will include one upgradient sample (SD-01), one downgradient sample (SD-06), and four samples (SD-02 to SD-05) equally spaced along the drainage ditch opposite the Lenz Oil site (Figure 3-3). One surface soil sample will be collected from each bank of the drainage ditch, opposite each sediment sample location and midway between the slope crest and the drainage channel (SS-01A through SS-06A and SS-01B through SS-06B). See Figure 3-3. Unless results indicate a need for additional sampling, these locations will be sampled only once.

The sediment and off-site soil sample locations are spaced at 150-foot intervals along the drainage ditch and were selected to evaluate sediment contamination upstream, downstream, and adjacent to the site. The purpose of sampling soil from the banks of the drainage ditch is to determine if contamination entering the ditch

has migrated from the north side, south side, or both sides of the ditch. Samples SD01, SS01A, and SS01B will be used to identify the types and magnitude of contamination attributable to sources upstream of the Lenz Oil Site, whereas samples SD02 to SD05 and samples SS02B to SS05B will be used to identify contamination attributable to the Lenz Oil Site. Samples SS02A to SS05A are intended to document contamination entering the drainage system from the northwest side. The type and magnitude of contamination in the drainage sediment and soil downstream of the site will be assessed from samples SD06, SS06A, and SS06B. The soil samples (SS01 to SS06) will also help to define the lateral extent of sediment contamination, if any. Sediment samples from the ditch will be taken after the collection of surface water samples to avoid cross-contaminating the water samples.

3.4 Surface Water Sampling

Surface water samples will be collected from the drainage ditch at the same locations as the sediment samples to evaluate potential releases of contamination to the drainage system water (Figure 3-4). Surface water samples will be collected upstream of the site (SW-01), downstream of the site (SW-06), and adjacent to the site (SW-02 to SW-05). These samples will be analyzed for TCL organics, TAL total metals, and TAL cyanide. The rationale for selecting the surface water sample locations is the same as the rationale for selecting the sediment sample locations (see Section 3.3). Surface water samples will be taken prior to sediment sample collection to avoid collecting turbid water. Surface water will be sampled only once unless results necessitate additional sampling.

3.5 Soil Gas Sampling

A soil gas investigation will be conducted to evaluate the areal distribution of volatile organic contamination downgradient of the Lenz Oil site. Soil gas sampling permits the measurement of organic vapors that volatilize from contamination in the ground water and are present in the soil pores of the unsaturated zone. As a result of the quantitative analysis of specific volatile organic compounds, a potential ground water contaminant plume below the site can be identified and assessed.

The soil gas investigation will be conducted in the open areas south of the Lenz Oil site unless ground water elevation data indicate possible plume migration in another area (Figure 3-5). Sampling points will be located at 50-foot intervals along southwest-northeast trending traverses spaced 100-feet apart. These locations will coincide with the grid system established earlier in the RI. Soil gas samples will be collected from a depth of 3 feet below ground surface. An estimated 32 investigative soil gas samples are planned for this task; however, additional samples will be collected if necessary. Table 3-2 includes a summary of the data collection effort for the soil gas investigation. The number and type of QA/QC samples were selected following the guidelines presented in Appendix C, Part 6 of the USEPA DQO Guidance.

3.6 Air Sampling

Semiquantitative ambient air screening will be conducted for health and safety purposes at regular intervals on and around the site by using an HNu. Background ambient VOC concentrations will be

determined by measuring ambient conditions upwind of the site. No quantitative air sampling is planned for this investigation because USEPA's site inspection and Hazard Ranking Evaluation indicated that no air contamination was present at the site or was expected. The need for and scope of future quantitative air sampling will be evaluated based on: (1) the semiquantitative ambient air screening results, (2) the soil gas results, (3) the surficial soil sample results, and (4) the potential for off-site exposure from air contamination, if any. Quantitative air sampling, if needed, would be conducted as part of a Phase II investigation.

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4.0 SAMPLE DESIGNATION

The following sample numbering system will be instituted for the Lenz Oil Site RI to ensure proper documentation and analysis of each sample taken. Each sample bottle will be labeled with the following information:

- o Name of Site - Lenz Oil (LO)
- o Two letter code for sample type:
 - MW - Monitoring Well
 - SB - Soil Boring
 - SW - Surface Water
 - SG - Soil Gas
 - SD - Sediment
 - SS - Surface Soil
- o Numerical location identification (sequential beginning w/01 for each type). Plus a depth modifier such as:
 - S - Shallow well,
 - D - Deep Well
 - A - 0'- 3' Soil Interval
 - B - 3'- 5' Soil Interval
- o Sample Matrix Code:
 - GW - Ground Water
 - S - Soil

SD - Sediment
A - Ash
SG - Soil Gas
SW - Surface Water

o QA/QC Sample Modifier (if needed):

FB - Field Blank or Rinsate
FD - Field Duplicate or Replicate
TB - Trip Blank
MS - Matrix Spike/Matrix Spike Duplicate

o -
Name and Affiliation of Collector

o Date and Time Collected

o Analysis requested:

VOL = TCL Volatiles
SV = TCL Semivolatiles
PP = TCL Pesticides/PCBs
MET = TAL Metals
CY = TAL Cyanide
TMET = TCLP Metals
TOC = Total Organic Carbon
TP = Total Porosity
PS = Particle Size

All of the following information for each sample will be carefully recorded in the field notebook:

o Sample Designation (LO-Y###Z-*\$):

LO - Designates Lenz Oil

Y = Sampling round number (1, 2)

= Sample location number (01, 02, 03, 04)
or (101, 102, etc.)

Z = Depth Modifier (e.g., S for shallow well,
D for deep well, A for 0'- 2.5' soil
interval, etc.)

* = Sample matrix - GW (ground water), S (Soil),
SD (sediment), A (Ash), SG (Soil Gas),
SW (surface water)

\$ = Sample Modifier (if needed) - FB (field blank),
FS (field duplicate), TB (trip blank), or MS
(MS/MSD)

o Name and Affiliation of Collector

o Date and Time Collected

o Analysis requested

o Any other information specific to sample.

The sample locations are shown in Figures 3-1 through 3-4.

The following is an example of an entry in the field notebook and the corresponding container label information.

Field Notebook:

LO-102S-GW
John Doe, ERM
1/31/90, 14:00 EST
SV

Label:

Lenz Oil
MW02S
John Doe, ERM
1/31/90, 14:00
SV, Water Sample

This example represents a sample (in this case, ground water) taken during the first round at well 02 from the shallow well (S) to be analyzed for semivolatiles (SV).

5.0 SAMPLING EQUIPMENT AND PROCEDURES

This section details the field procedures to be used at the Lenz Oil Site during the Remedial Investigation. Tables 3-1 and 3-2 contain summaries of the source characterization and site characterization sampling and analysis programs, respectively.

5.1 Monitoring Network Design and Well Installation

Evaluation of the surficial aquifer at the Lenz Oil Site will be based on data collected from 11 monitoring well clusters (Figure 3-1). Five well clusters (G-101, G-102, G-104, G-105 and G-106) already exist at the site and, to the extent possible, have been incorporated into the proposed monitoring well network. However, three of the existing wells (G-105S, G-105D and G-106D) are either nonfunctional or have questionable integrity. These wells will be abandoned in place in accordance with IEPA regulations. The wells in cluster G-105 are located within the main soil excavation area. In order to avoid the risk of puncturing the visqueen liner at the base of the excavation, these wells will not be replaced with new wells. However, the deep well in cluster G-106 is not in the excavation area and will be replaced with a new deep monitoring well.

The existing monitoring well network will be supplemented with seven additional two-well clusters. The additional well clusters will be located downgradient and surrounding the primary source of contamination to assess the severity, extent, and fate of ground water contamination. Preliminary locations of the monitoring well clusters have been selected (Figure 3-1), but these locations may be revised as a result of field conditions and/or fracture analysis

and soil gas findings. The rationale for selecting each monitoring well location is discussed in Section 3.1 of this Plan.

Each new monitoring well cluster will consist of a water table well and a deep well completed with the top of the screen 30 feet below the water table if significant bedrock fractures are present at that depth. If fractures are not present at that depth or at a slightly shallower depth, these boreholes will be advanced until significant fractures are encountered. The wells will then be set so that they are open to these fractures.

To conform with the existing monitoring wells, all of the new wells will be completed using stainless steel screens and risers. Ten-foot screens will be used for water table wells, and 5-foot screens will be used for the deep wells. The tops of the water table screens will be placed 3 feet above the water table at the time of installation. Monitoring wells will be constructed to comply with applicable Federal, State, and local regulations concerning ground water monitoring of hazardous waste management sites.

The following procedures will be used to install the monitoring well clusters at the Lenz Oil site (Figure 5-1):

- o The boring for the deep well will be advanced through unconsolidated deposits using a nominal 4-inch I.D., hollow-stem auger.
- o Soil will be continuously sampled using a split-spoon sampler to bedrock or total depth, whichever comes first. The soil will be logged by a qualified geologist using the Unified Soil Classification System (USCS).

This will be accomplished by describing the length, color, density, grain size, sorting, composition, structure, and moisture content of the soil sample from visual observation. The density of the soil will be determined by using the standard blow count method and the color of the soil will be identified by comparison with a rock color chart. Soil will be classified according to the USCS by using the qualitative field description and the appropriate field tests described on Table 5-1.

- o Soil samples will be field screened with an HNu photoionization detector. The purpose of the field screening is to provide: (1) a qualitative relative measure of the VOC contamination encountered in the soil and ground water in each boring, and (2) health and safety data. The screening data will be used to choose appropriate levels of personnel protection and will be considered before setting the well screen. However, the screening results will not be a primary source of decision-making data.
- o After the soil has been logged, it will be placed in a 55-gallon drum along with the drill cuttings.
- o If necessary, the boring will be advanced in bedrock using an NX-size wireline core barrel

and reamed to at least 5-5/8 inches using a rotary bit. Every effort will be made to maximize core recovery and sample quality. A nominal 6-inch I.D. temporary casing will be installed and seated in the top of the bedrock prior to initiating coring.

- o A detailed geologic log of the cores will be prepared by a qualified geologist using standard geologic descriptors and nomenclature. The following information will be recorded: depth; core recovery; lithology; rock quality designation (RQD); physical condition, in fillings; coatings; spacings; roughness; dissolution features; and orientation of joints, fractures, and bedding planes. All cores will be photographed.
- o Upon drilling to 30 feet below the water, the aquifer material will be evaluated. If significant fractures are present at that depth, a well consisting of a 5-foot screen with 0.010-inch continuous slot openings will be installed opposite the fractures. The screen will be fitted with a 5-foot subscreen and a riser of appropriate length. All well materials will be 2 inches in diameter and composed of flush threaded 316 stainless steel.
- o The annular space around the screen and subscreen will be backfilled with clean silica

sand to 2 feet above the top of the screen. The sand will be free of silt and of appropriate size for the well screen slot openings.

- o A minimum of 2 feet of fine sand will be placed above the sand pack to prevent the overlying bentonite grout from infiltrating the sand pack.
- o The space above the fine sand collar will be filled with a bentonite grout placed with a tremie pipe. The grout seal shall be prepared using an appropriate mixture of bentonite powder and water. The bentonite grout will extend to approximately 8 feet below ground surface.
- o Nonshrink cement will be placed in the borehole from 2 to 8 feet below ground surface (i.e., through the frost zone).
- o A 4-inch diameter protective steel casing with a hinged locking steel cover will be cemented in place to a depth of 2.0 feet below the ground surface. The cement will be sloped

away from the casing to promote drainage away from the well.

- o The riser pipe will be fitted with a vented cap.
- o The boring for the shallow well in each cluster will be located as close as is practical to the deep well. The borehole will be advanced through the unconsolidated deposits using a nominal 4-inch I.D., hollow-stem auger and through bedrock using a 5-5/8 inch rotary bit. Soil samples and cores will not be collected from the shallow borings due to their proximity to the deep borings.
- o Upon encountering ground water, the boring will be extended an additional 12 feet, and a well consisting of a continuous 5-foot subscreen and a 10-foot screen with 0.010-inch continuous slot openings will be installed. The well will consist of 2-inch diameter, flush-thread, 316 stainless steel, and the top of the screen will extend 3 feet above the water table.
- o The annular space around the screen and subscreen of this shallow well will be backfilled to 2 feet above the top of the screen with the same silica sand used for the sandpack in the deep well.

- o A minimum of 2 feet of compressed bentonite pellets will be placed above the sandpack to seal the annular space around the riser and prevent the overlying grout from infiltrating the sandpack.
- o The rest of the shallow well will be constructed exactly like the deep well.
- o Soil and rock cuttings generated during drilling will be collected, containerized in 55-gallon drums, and handled, as appropriate, based on chemical results.

Geotechnical samples will be collected from aquifer materials composed of unconsolidated soil. This soil will be taken from split spoons samples collected during installation of the monitoring wells. No fewer than one sample of each soil type encountered below the water table at the site will be collected. Prior to placing the samples in the appropriate sample containers, the length, color, density, grain size, sorting, composition structure, and moisture content of the soil will be described and the soil will be classified according to the uses. The samples for particle size and TOC analysis will be taken directly from the split spoon sampler and placed in the appropriate sample container. TOC samples will be collected first, if both analyses will be run on soil from the same split spoon.

Samples to be analyzed for total porosity will be collected by inserting three 2.5- x 6.0-inch brass liners in a 3.0-inch O.D. split spoon sampler and driving the split spoon as usual. Of these brass liners, the one that is completely filled with the soil type

of interest will be sealed with plastic caps to avoid disturbing the sample.

The field log book, sample log sheets, labels, tags and chain-of-custody sheets will be filled out with the geotechnical sample identification properly designated and logged. The TOC samples will be cooled to 4°C. Samples will be shipped to the laboratory via overnight carrier within a time frame that will not violate sample holding times.

Two duplicate geotechnical samples will be obtained for QA/QC purposes. The duplicate particle size and TOC samples will be collected by:

1. Ensuring that enough sample volume was collected by fitting the split spoon with a retainer and/or using a large split spoon,
2. Alternately dispensing soil "grabbed" from several portions of the split spoon into the appropriate sample containers,
3. Filling out the appropriate sample documentation and properly designating and logging the duplicate sample, and
4. Preserving handling and shipping the duplicate samples according to the same procedures as investigative samples.

The duplicate total porosity sample will be collected and handled as described above, except that the duplicate will consist of soil

in the second brass liner in a series of two liners from the same split spoon sampler. Both the investigative sample and the duplicate sample will be sealed immediately to avoid disturbing the samples.

Following installation, monitoring wells will be developed to provide low-turbidity, representative ground water samples. Well development will be started no sooner than 48 hours following the grouting of the wells. As development water is removed from the well, representative samples will be collected in a plastic cup, and values of pH, conductivity and temperature will be obtained from each sample according to the SOPs included in the QAPP. The well will continue to be developed until at least three well volumes have been removed; it yields low turbidity water; and consistent values of pH, conductivity and temperature have been obtained (i.e., successive samples exhibit pH values within 0.10 pH units of each other, conductivity values within 10% of each other and temperature values within 1.0° C of each other). Equipment used in well development may include surge blocks, bailers, or hand pumps. Ground water removed during well development will be collected, stored in containers, and handled as appropriate based on the results of chemical analysis.

5.2 Ground Water Sampling

One round of ground water samples will be collected from each of the monitoring wells (i.e., 23 ground water samples). The procedure for sampling the wells is described below.

Standing water in the wells will be removed prior to sampling by purging each well of a minimum of three well volumes and until stabilization of temperature, pH, and specific conductance occurs.

The well will be considered stable when three successive water samples exhibit pH values within 0.10 units of each other, conductivity values within 10% of each other, and temperature values within 1.0° C of each other. If the well goes dry before three casing volumes have been removed, samples will be taken as soon as the well recovers.

Dedicated Teflon bailers will be used for purging the wells. Purged water will be placed in containers for subsequent handling based upon on results of chemical analysis. Bailers and all other equipment inserted in the well shall be decontaminated prior to insertion into the well.

Decontamination of the sampling equipment will be conducted as follows:

- Step 1 Steam clean or scrub equipment with a nonphosphate detergent mixed with potable water,
- Step 2 Rinse with potable water,
- Step 3 Rinse twice with distilled water,
- Step 4 Air dry, and
- Step 5 Place in clean polyethylene bag or wrap in aluminum foil with shiny-side out when not in use and during transport.

Bailer ropes and sampling gloves will be discarded after sampling each well.

During sample withdrawal, special care will be taken to avoid physically altering or chemically contaminating samples. Sampling will be performed with dedicated bottom filling, Teflon bailers. Ground water pH, specific conductance, and temperature will be determined in the field on secured samples and indicated in the field notebook. Samples will be collected in the following order: (1) TCL volatile organic compounds, (2) TCL semivolatile organic compounds, (3) TCL PCBs/pesticides, (4) TAL total metals, (5) TAL dissolved metals, and (6) TAL cyanide. QA/QC samples (i.e., field blanks, field duplicates, matrix spike/matrix spike duplicates, and trip blanks) will be collected at the frequency indicated on Table 3-2. Field blanks will be obtained by pouring distilled water through a specific decontaminated bailer and collecting the sample in the appropriate sample containers. Field duplicate and matrix spike/matrix spike duplicate samples will consist of an additional volume of a designated investigative sample. The additional volume will be collected by alternately filling bottles for each sample parameter (i.e., the volatile organic sample jars for both the investigative and the duplicate sample would be collected before any semivolatile organic sample jars were filled. Trip blanks composed of laboratory grade deionized water will be prepared by the lab and shipped with each sample container. All samples will be documented in the field notebook as described in Section 4.0.

5.3 On-Site Soil Sampling

The on-site soil investigation has been designed to: (1) determine the magnitude and extent of soil contamination, if any, remaining at the Lenz Oil Site following the expedited remedial activities conducted by IEPA, (2) document the quality of the incinerator ash used for backfill in the main excavation area to determine whether or not it meets treatment standards, and (3) indirectly assess the

integrity of the visqueen liner placed in the main excavation area by determining if the backfill immediately above the liner has been recontaminated by ground water. These objectives will be accomplished by drilling and continuously sampling 23 on-site soil borings and analyzing a minimum of 57 investigatory soil samples.

Soil sampling will be conducted within the main excavation area to confirm that the backfilled material satisfied established treatment standards and to assess the integrity of the visqueen liner. The sampling will be limited to shallow depths to avoid puncturing the visqueen liner and possibly allowing contaminated ground water to migrate into the clean backfill. In most areas, the soil sampling will extend to a depth of 9 feet. A selected number of soil borings will be limited to a depth of 5 feet.

Samples will be collected outside the main excavation area to: (1) verify if the horizontal extent of excavation was sufficient, (2) investigate the soil staining adjacent to the existing fire hydrant, and (3) verify that excavation in the former surface impoundment area was sufficient. An aerial photograph of the site showed dark soil staining adjacent to the existing fire hydrant. This area will be identified in the field and sampled. The rationale for sampling here is to determine if there is any contamination associated with the soil staining. Soil borings outside the main excavation area will be drilled until bedrock is encountered. Additional information regarding the rationale for selecting the soil boring locations, sample depths, screening method, default sample depths, and analytical parameters is presented in Section 3.2 of this document.

The soil boring locations will be numbered SB01 to SB23 (Figure 3-2). All borings will be advanced to total depth using 3-1/4 inch

inside diameter (ID), hollow-stem augers equipped with a plug at the bottom. Continuous samples will be collected from all borings for soil characterization and for chemical analysis. A 5 foot long, 3-inch outside diameter (OD) steel continuous sampler will be used to collect samples for screening and analysis. Upon completion of sampling, the soil borings will be backfilled using drill cuttings from the boring.

A total of 57 investigative samples, 6 duplicates, and 6 rinsates will be collected for the analyses indicated in Table 3-1. All samples collected within the main excavation area to a depth of 5 feet will be analyzed for TAL metals, TAL cyanide, and TCLP metals (Table 3-3). Samples from the bottom of the main excavation area (the 5- to 9-foot depth interval) will be analyzed for TCL volatile organics, TCL semivolatile organics, and TCL PCBs/pesticides in addition to the inorganic analyses listed above (Table 3-3). Samples collected outside the main excavation area will be analyzed for TCL volatile organics, TCL semivolatile organics, TCL PCBs/pesticides, and TAL metals and TAL cyanide (Table 13-3).

Soil borings SB01, SB02, and SB03, located west of the main excavation area, will be spaced 100 feet apart and will extend to bedrock. These borings will initially be drilled to a depth of 5 feet. Soil obtained from the 0- to 2.5-foot and 2.5- to 5-foot intervals will be screened for VOCs with an HNu. An analytical sample will be collected from the interval exhibiting the highest HNu reading. If neither sample exhibits a PID reading above background, an analytical sample will be collected from the 2.5- to 5.0-foot interval. Soil will continue to be sampled in 5-foot intervals and screened in 2.5-foot intervals until bedrock is encountered. A second analytical sample will be collected from the 2.5-foot interval of soil between a depth of 5 feet and bedrock

that exhibits the highest HNu reading. If none of this soil exhibits a HNu reading above background, the analytical sample will be collected from the 2.5-foot interval immediately above bedrock. A total of 6 investigative samples will be collected from these three locations and will be analyzed for TAL metals and cyanide and TCL volatile organics, semivolatile organics, pesticides and PCBs. The data acquired from these borings will supplement existing information on the horizontal and vertical extent of soil contamination in the western portion of the site and confirm whether the soil staining observed in the aerial photograph from April 1985 is directly related to soil contamination.

Soil borings SB04 through SB12 are located within the main excavation area, which was backfilled with incinerator ash. All nine borings within the excavation area will be on a 100' x 100' grid. Borings SB05, SB06, SB07, SB09, and SB12 will extend to a depth of 9 feet, and borings SB04, SB08, SB10, and SB11 will extend to a depth of 5 feet. Two soil samples from depths of 0 to 2.5 and 2.5 to 5 feet will be collected for chemical analysis from each of the 5-foot borings. Two soil samples also will be selected for chemical analysis from each of the 9-foot borings. One analytical sample will be collected from the 2.5- to 5.0-foot interval and the other will be collected from the 2-foot interval between 5 and 9 feet that exhibits the highest HNu reading. If no HNu readings above background are detected, the deep analytical sample will be collected from the 7- to 9-foot interval. A total of 18 investigative soil samples will be collected and analyzed for TCLP metals, TAL metals, and cyanide from the borings. Samples from 5- to 9-foot intervals in borings SB05, SB06, SB09, and SB12 will also be analyzed for TCL volatiles, semivolatiles, PCBs and pesticides.

Metals analyses are required because metals may be present in the ash. Potential sources of metals in the ash include residual from used oils handled by Lenz Oil Service, Inc. and residual from the metal containers that were shredded and incinerated. Any volatile organics in the excavated soil fed to the incinerator would have been destroyed at the temperatures at which incinerators normally operate (1,800-2,200°F). Consequently, the shallow ash is not expected to contain organics and does not require organic analyses. The analytical data acquired from the shallow backfilled incinerated ash will be used to confirm whether the quality of the backfill conformed to treatment standards. Ash in the lower portion of the excavation area may be contaminated with organic compounds if the liner has not kept ground water from infiltrating the backfill. Therefore, analytical data gathered from the lower portion of the backfilled incinerator ash will be used to confirm the integrity of the liner and the quality of the backfill material.

Soil borings SB14, SB15, SB23 and SB16 are located east of the main excavation area (Figure 3-2). These soil borings will be located approximately 50 feet apart and will extend to bedrock. These borings will be drilled and screened with a HNu as previously described. Analytical samples will be collected from the 2.5-foot intervals exhibiting the highest HNu reading between the depths of 0 to 5 feet, 5 to 9 feet, and 9 feet to bedrock. Thus, three samples will be collected from each boring. If no HNu readings above background are detected, analytical samples will be collected at the 2.5- to 5.0-foot interval, the 7.0- to 9.0-foot interval, and the 2.5-foot interval immediately above bedrock. A total of 12 investigative samples from these four locations will be analyzed for TAL metals and cyanide and TCL volatile organics, semivolatile organics, pesticides, and PCBs. The rationale for collecting these

samples is to verify that the horizontal extent of excavation was sufficient in the eastern portion of the site.

Soil borings SB13, SB17, and SB18 are located in the former surface impoundment area, northeast of the main excavation area (Figure 3-2). These borings will be spaced approximately 50 feet apart and will extend to bedrock. These borings will be drilled and screened with a HNu as previously described. Analytical samples will be collected from the 2.5-foot intervals exhibiting the highest HNu reading between the depths of 0 to 5 feet, 5 to 9 feet, and 9 feet to bedrock. Thus, three samples will be collected from each boring. If no HNu readings above background are detected, analytical samples will be collected at the 2.5- to 5.0-foot interval, the 7.0- to 9.0-foot interval, and the 2.5-foot interval immediately above bedrock. Nine investigative samples will be collected from the former surface impoundment area and analyzed for TCL volatile organics, semivolatile organics, PCBs, and pesticides and TAL metals and cyanide. The rationale for collecting these samples is to verify that the hot spot excavation conducted in the former surface impoundment area was sufficient and to determine the nature and extent of any residual soil contamination.

Soil borings SB19, SB20, SB22, and SB23 are located north and south of the main excavation area, along its perimeter. These borings will be drilled to bedrock and screened in 2.5-foot intervals with a HNu as previously described. Analytical samples will be collected from the 2.5-foot intervals exhibiting the highest HNu readings between the depth of 0 to 5 feet, 5 to 9 feet, and 9 feet to bedrock. If no HNu readings above background are detected, analytical samples will be collected from the 2.5- to 5.0-foot interval, the 7.0- to 9.0-foot interval, and the 2.5- foot interval immediately above bedrock. Three investigative samples will be

collected from each boring, for a total of 12 samples. The samples will be analyzed for TCL volatiles, semivolatiles, PCBs, and pesticides and TAL metals and cyanide. The rationale for collecting these samples is to verify that the horizontal extent of excavation in the main excavation area was sufficient in the northern and southern portions of the site.

The following procedure will be used by IEPA or its contractor for soil boring split-spoon sampling:

1. Wear appropriate health and safety equipment as outlined in the Health and Safety Plan.
2. Advance the hollow-stem augers and the 3-inch O.D. continuous sampler to the desired sampling depth.
3. The process of jetting through the sampler and then sampling when the desired depth is reached shall not be permitted.
4. Bring sampler to the surface and remove both ends and one-half of the sampler so that the recovered soil rests in the remaining half of the barrel. Place the barrel on clean polyethylene sheeting on a table or other raised surface. Describe carefully the length, composition, structure, consistency, color, and condition of the recovered soil.
5. Repeat this operation at each sampling horizon.

6. Homogenize all soil samples for analyses except VOAs in a stainless steel pan or bowl with stainless steel spoons prior to placing the samples into containers. VOA samples must be taken as grab samples collected at various depths within the sampling interval immediately upon opening the split spoon. Sample fractions will be collected in the following order: volatile organics first, semivolatile organics, PCBs/pesticides second, TAL metals and cyanide third, and TCLP metals fourth.
7. Fill out the field log book, sample log sheet, labels, tags, and chain-of-custody for analytical samples.
8. Cool analytical samples on ice to 4°C. Samples will be shipped to the laboratory via overnight carrier within a time frame that will not violate sample holding times.
9. Decontaminate the sampler prior to collection of each sample as described below.

The following procedure will be used to collect duplicate soil samples:

1. Identify the soil interval from which a duplicate sample will be collected and take steps (i.e., fit the sampler with a retainer

or use a larger sampler) to ensure collection of enough sample volume.

2. Collect and log the sample as previously described.
3. Collect VOA samples immediately upon opening the sampler by alternately dispensing soil from the sampler to the VOA jars using a stainless steel spoon. Soil will be "grabbed" from several portions of the sample interval and dispensed into both the investigative and the duplicate sample bottles.
4. The remaining soil will then be placed in a stainless steel pan or bowl and homogenized with a stainless steel spoon. The soil will then be alternately dispensed between the investigative sample bottles and the duplicate sample bottles.
5. The field log book, sample log sheet, labels, tags, and chain-of-custody sheets will be filled out with the duplicate sample properly designated and logged.
6. Duplicate samples will be preserved, handled and shipped following the same procedures as the investigative samples.

Rinsate samples will be collected to document the effectiveness of the equipment decontamination procedures. Because the rinsate

samples are water and the investigation samples that they will be compared to are soils, it may be difficult to quantitatively evaluate the rinsate data. However, the rinsate data will provide a qualitative assessment of the efficiency of decontamination procedures. The rinsate samples will be prepared and handled according to the following procedures:

1. Decontaminate all sampling equipment prior to the sampling event, following procedures specified below.
2. VOA rinsate samples will be collected first and separately from the water collected for other chemical analyses. A rinsate must be taken for all analyses.
3. Pour laboratory grade deionized water through the sampler, stainless steel bowl, stainless steel spoon, and any other equipment used for sample collection and into the required sample bottles for all analyses.
4. Add the required preservatives and seal sample jars or bottles.
5. Fill out the field log book, sample summary sheet, tags, and chain-of-custody.
6. Keep rinsate samples cooled on ice to 4°C. Samples will be shipped to the laboratory via overnight carrier within a time frame that will not violate sample holding times.

Rinsate sample results will be used to identify potential cross-contamination resulting from repeatedly using the same sample equipment. Contaminants introduced by the sampling procedure may also be identified.

All equipment involved in field sampling activities will be decontaminated prior to and upon completion of sample collection. Drilling equipment will be steam cleaned prior to each boring and before the equipment is removed from the site. Pressurized steam will be used to remove all visible excess material from the augers, the back of the drilling rig, and other parts of the rig that contact augers, rods, and samplers.

Decontamination of the sampling equipment will be conducted according to the following procedure:

- Step 1 Steam clean or scrub equipment with a nonphosphate detergent mixed with potable water,
- Step 2 Rinse with potable water,
- Step 3 Rinse twice with distilled water,
- Step 4 Air dry, and
- Step 5 Place in clean polyethylene bag or wrap in aluminum foil with shiny-side out when not in use and during transport.

Extraneous contamination and cross-contamination will be controlled by the decontamination procedure, wrapping sampling equipment when not in use, and changing and disposing of the sampler's gloves between samples. Personnel directly involved in equipment decontamination will wear protective clothing as specified in the Health and Safety Plan.

5.4 Sediment and Off-Site Soil Sampling

Sediment and off-site soil sampling will be conducted along the drainage ditch, northwest of the site (Figure 3-3). One sediment and two soil samples will be collected from each of six sampling cross-sections along the ditch. The upstream sediment and soil samples will be considered background samples for the purpose of separating sediment contamination contributed by upstream sources from that contributed by the Lenz Oil site, if any. The rationale for selecting the other sample locations is discussed in Section 3.3 of this document, and the procedure for collecting the investigative samples is described below.

- o The center point of the channel cross-section will be established at the locations shown on Figure 3-3.
- o A stainless steel Eckman dredge or hand auger will be used to obtain bottom sediment grab samples at the center point of each cross-section if surface water is present in the ditch. If no water is present in the ditch, a stainless steel trowel or hand auger will be used to collect a sediment grab sample.

- o The quarter points of each cross-section will be established, and a hand auger will be used to collect a composite sample from the 0- to 12-inch depth at each surface soil location.
- o A representative portion of each sample will be immediately placed in a VOA sample container. The remainder of each sample will be placed in a large stainless steel bowl.
- o The soils in the stainless steel bowl will be mixed for homogeneity in the field and then placed in appropriate sample containers for TCL organic compounds and TAL metals and cyanide analyses. The sample analytical fractions will be collected in the following order: (1) TCL volatile organic compounds, (2) TCL semivolatile organic compounds and PCBs/pesticides, and (3) TAL metals and cyanide.
- o All sediment sampling efforts will progress in an upstream direction to minimize cross-contamination of samples, and sediment sampling will occur after all the surface water samples have been collected to avoid collecting turbid surface water samples.
- o All samples will be screened for the presence of volatile organic vapors using an HNu photoionization meter and then described for content from visual observations.

- o The field book, sample log sheets, labels, tags, and chain-of-custody sheets will be filled out with the sample numbers properly designated and logged.
- o The investigative samples will be preserved, handled, and shipped following the procedures described in Section 6.1 and Table 6-1.

One duplicate sediment sample and two duplicate soil samples will be obtained for QA/QC purposes. The following procedure will be used to collect duplicate soil and sediment samples:

1. Identify the locations from which duplicate samples will be collected and take steps to ensure the collection of enough sample volume (i.e., collect twice the volume of soil/sediment needed for an investigatory sample).
2. Collect VOC samples immediately by alternately dispensing soil/sediment from the sampling device to the VOC jars using a stainless steel spoon. The VOC sample will be "grabbed" from several portions of the sample interval and dispensed into both the investigative and the duplicate sample bottles.
3. The remaining soil/sediment will then be placed in a stainless steel bowl or pan and homogenized with a stainless steel spoon. The

soil/sediment will then be alternately dispensed between the investigative sample bottles and the duplicate sample bottles. The sample analytical fractions will be collected in the same order as the investigative samples.

4. The field book, sample log sheet, labels, tags, and chain-of-custody sheets will be filled out with the duplicate sample properly designated and logged.
5. Duplicate samples will be preserved, handled, and shipped following the same procedures as the investigative samples.

Rinsate samples will be collected to document the effectiveness of the equipment decontamination procedures. One rinsate sample will be taken from the sediment sampling equipment, and one rinsate sample will be collected from the soil sampling equipment. The rinsate samples will be prepared and handled according to the following procedures:

1. Decontaminate the sampling equipment using the procedures described below.
2. Pour laboratory grade deionized water over the sampling devices, stainless steel bowl, stainless steel spoon, and any other equipment used for sample collection and into the required sample bottles for analyses. All of

the sample fractions will be collected in the same order as the investigative samples.

3. The field log book, sample log sheet, labels, tags, and chain-of-custody sheets will be filled out with the rinsate sample properly designated and logged.
4. The rinsate samples will be preserved, handled, and shipped following the same procedures designated for the aqueous investigative samples.

One soil and one sediment sample will be designated for MS/MSD analysis. Because no additional sample volume is required for MS/MSD analysis of soils and sediments, the sample collection procedure is the same as for investigative samples. However, the investigative samples selected for MS/MSD analysis will be properly designated and logged on the chain-of-custody sheets, sample log sheets, labels, and tags and in the field log book. MS/MSD samples will be preserved, handled, and shipped following the same procedures as investigative samples.

All soil and sediment sampling equipment will be decontaminated prior to initiating sampling, between sample locations, and upon completion of sample collection. Decontamination of the sampling equipment will be conducted according to the following procedure:

- Step 1 Steam clean or scrub the equipment
 with a non-phosphate detergent mixed
 with potable water,

- Step 2 Rinse with potable water;
- Step 3 Rinse twice with distilled water,
- Step 4 Air dry, and
- Step 5 Place in clean polyethylene bag or
 wrap in aluminum foil with shiny-
 side out when not in use and during
 transport.

5.5 Surface Water Sampling

Surface water samples will be collected from the drainage ditch northwest of the site to evaluate potential releases of contamination to the drainage ditch water. Six surface water samples will be taken at the same locations as the sediment samples (Figure 3-4). One surface water sample (SW01) will be collected upstream of the site and will be considered a background sample. Samples SW02 through SW05 will be collected adjacent to the site, and sample SW06 will be collected downstream of the site (Figure 3-4). The rationale for selecting the surface water sample locations is presented in Section 3.4 of this document.

The procedure for collecting investigative surface water samples is as follows:

1. The sample location will be identified in field.
2. Surface water will be collected by individually submerging the sample containers

in the drainage ditch water. The container mouth will be positioned so it faces upstream, while the sampling personnel are standing downstream so as not to stir up bottom sediment and contaminate the sample. Other precautions to be exercised to minimize the risk of contamination from sediment include: (1) not allowing the sample container to contact the sediment during sampling, (2) filling the container in a manner that prevents localized eddy phenomena from stirring up sediment, and (3) collecting the surface water samples before taking the sediment samples.

3. The sample analytical fractions will be collected in the following order: (1) TCL volatile organics, (2) TCL semivolatile organics, (3) TCL PCBs/pesticides, (4) TAL total metals, and (5) TAL cyanide.
4. The surface water sampling effort will progress in the upstream direction to minimize cross-contamination of samples.
5. The field book, sample log sheets, labels, tags, and chain-of-custody sheets will be filled out with the sample identification properly designated and logged.
6. The investigative samples will be preserved, handled, and shipped following the procedures

described in Section 6.1 and Table 6-1. Because the sample containers will be filled by submerging them in the surface water, the sample preservatives will be added after sample collection.

One duplicate surface water sample will be collected in accordance with the procedure described below:

1. The investigative sample location from which a duplicate sample will be collected will be identified.
2. The duplicate sample will be collected at the same time and location as one of the investigative samples using the same procedure outlined in Step 2 of the sampling procedure for investigative samples.
3. The duplicate and investigative sample bottles will be alternately filled in the following order: (1) TCL volatile organics, (2) TCL semivolatile organics, (3) TCL PCBs/pesticides, (4) TAL total metals, and (5) TAL cyanide. Thus, all of the volatile organic sample bottles for both the duplicate and the investigative sample will be filled before beginning to fill the semivolatile organic sample bottles and so on.
4. The field log book, sample log sheet, labels, tags, and chain-of-custody sheets will be

filled out with the duplicate sample properly designated and logged.

5. The duplicate sample will be preserved, handled, and shipped following the same procedures as the investigative samples.

One field blank sample will be collected to document the effectiveness of the personnel and equipment decontamination procedures. The field blank will be collected according to the following procedures:

1. An investigative sample location will be selected for collection of a field blank and the sample bottles will be transported to that location.
2. The sample will be collected by pouring laboratory-grade deionized water into the sample bottles at the investigative sample location. The field blank sample bottles will be filled in the same order as described for investigative samples. The field blank will be collected before the investigative sample to avoid the possibility of cross-contamination.
3. The field book, sample log sheet, labels, tags, and chain-of-custody sheets will be filled out with the field blank properly designated and logged.

4. The field blank will be preserved, handled, and shipped following the same procedures as the investigative samples.

One surface water investigate sample will be designated for MS/MSD analysis. The sample will be collected following the sample procedure as other investigative samples except that triple the volatile organic sample volume and double the semivolatile organic and PCBs/pesticide sample volume will be collected. The investigative samples selected for MS/MSD analysis will be properly designated and logged on the chain-of-custody sheets, sample log sheets, labels, tags, and in the field log book. MS/MSD samples will be preserved, handled, and shipped following the same procedures as investigative samples.

Trip blanks composed of laboratory-grade deionized water will be prepared at the laboratory, shipped with the sample bottles, and kept with the investigative samples throughout the surface water sampling event. Trip blanks will be shipped with the investigative samples to the laboratory and analyzed at a frequency of one per daily shipment.

5.6 Soil Gas Investigation

The soil gas procedure requires driving a perforated stainless steel probe into the soil and pulling a known quantity of soil vapor through a Teflon tube sampling train connected to an activated carbon sampling tube. The activated carbon sampling tubes will be analyzed as described in Appendix F of the QAPP. The source of the sampling tubes is described in Section 6.1 of the SAP and in Appendix F of the QAPP. The sampling train is designed to accommodate an HNu photoionization detector to enable field

measurement of the organic vapor concentrations in the soil gas. A schematic diagram of the soil gas sampling train is shown on Figure 5-2. The detailed sampling procedure to be used at Lenz Oil site is as follows:

1. A hollow-stem auger or hand auger hole, as appropriate, will be advanced to 18 inches above the target depth (3 feet) for the soil gas sample. A perforated stainless steel probe will be driven 18 inches beyond the auger.
2. A- gas-tight Teflon tubing arrangement is attached to the soil gas probe.
3. The Teflon tubing is connected to a flow meter/sampling pump system. The sampling train is initially purged at a flow rate of two liters per minute until the purged volume is greater than three times the volume of the soil gas sampling train.
4. Following completion of the presample purge, the shut-off valve is closed. The ends of two activated carbon tubes are broken to provide an opening at least one-half the internal diameter of the tube (2 mm). Each tube contains two sections of 20/40 mesh activated charcoal separated by a 2-millimeter portion of urethane foam. The adsorbing section contains 100 mg of charcoal, and the back-up section contains 50 mg. The activated carbon

tubes are placed in a series between the shut-off valve and the flow meter. Each tube should be positioned with the smaller (back-up) section of charcoal nearest the sampling pump. The second tube is used to distinguish breakthrough from the first tube.

5. The shut-off valve is then opened and soil vapor is pulled through the activated carbon tubes at a flow rate of 0.2 liters per minute for a total of 125 minutes (sample volume = 25 liters).
6. Upon completion of the sample interval, the shut-off valve is closed; and the activated charcoal tubes are removed, capped, labeled and placed in a cooler. The first tube in the series will be labeled the primary tube, and the second tube will be labeled the secondary tube. The tubes will be capped with plastic caps supplied by the lab.
7. The sampling train is then repurged for one minute and the shut-off valve is closed again. An HNu photoionization detector is attached to the sampling train immediately downstream of the shut-off valve. Next, the valve is opened, and the photoionization meter is read for total volatile organic concentration. The purpose of the HNu reading is to provide a real-time semiquantitative reading of the total volatile organic concentration in the

soil gas sample. These data will be plotted in the field and analyzed to determine if additional soil gas sampling locations are needed to delineate the extent of contamination. The HNu data allows the sampling grid to be expanded for the purpose of delineating the extent of obvious volatile organic contamination without having to demobilize, wait for laboratory results, and remobilize to collect additional samples.

8. The field log book, sample log sheets, labels, tags, and chain-of-custody sheets will be filled out with the sample identification properly designated and logged.
9. The soil gas samples will be preserved, handled, and shipped following the procedures described in Section 6.1 and Table 6-1. Specifically, the ends of the charcoal tubes will be capped, and a sample label will be adhered to the tube. The tube will then be inserted into a slit sponge and packed in a 500-ml, wide-mouth glass bottle. The bottle will be sealed, tagged, and placed in a ziplock plastic bag to ensure that the writing on the sample tag is not smeared by moisture in the cooler. The sample bottles will be packaged in a cooler as described in Section 6.1.

Duplicate (collocated) soil gas samples will be collected at a frequency of one per 10 or fewer investigative samples. The duplicate samples will be collected from investigative sample locations that are distributed over the entire soil gas investigation area. The sampling will be accomplished by driving two stainless steel probes approximately one (1) foot apart and simultaneously collecting a duplicate and an investigative sample using the sampling procedure described above. Following sample collection, the field log book, sample log sheets, labels, tags, and chain-of-custody sheets will be filled out with the investigative and duplicate samples properly identified and logged. The duplicate samples will be preserved, handled, and shipped according to the same procedures as the investigative samples.

Investigative samples will be designated for MS/MSD analysis at a frequency of one per 20 or fewer investigative samples. Samples designated for MS/MSD analysis require triple the normal sample volume for an investigative sample. This will be accomplished by driving three stainless steel probes approximately one (1) foot apart and simultaneously collecting an MS, an MSD, and an investigative sample, using the sampling procedure described above. Following sample collection, the field log book, sample log sheets, labels, tags, and chain-of-custody sheets will be filled out with the MS/MSD sample properly identified and logged.

Field blank/background samples will be collected at a frequency of one per 10 or fewer investigative samples. These samples will be collected by drawing ambient air from an upwind, off-site location through a decontaminated sampling train and collecting the sample on carbon tubes. The sampling procedure is the same as for investigative samples, except the stainless steel probe is positioned to collect atmospheric air rather than driven into the

ground to collect soil gas. Following the collection of a field blank sample, the field log book, sample log sheet, labels, tags, and chain-of-custody sheet will be filled out with the field blank identification properly designated and logged.

Trip blank samples will be sent for analysis at a frequency of one (i.e., two carbon tubes) per daily shipment. Trip blanks will consist of unbroken activated carbon tubes that are kept with the investigate samples throughout the sampling event. These unbroken tubes will then be broken, capped, preserved, and packaged for shipment and analysis with the investigative samples.

The following procedures will be used to decontaminate soil gas sampling equipment prior to any sampling and between sampling events:

1. The perforated stainless steel probe tip will be disconnected and steam cleaned to remove any residual contaminated soil.
2. The perforated probe tip will then be rinsed with distilled water and placed in a clean area to dry for approximately 15 minutes.
3. The Teflon tubing arrangement will be disconnected from the remaining probe section and purged with nitrogen to remove any residual soil vapor.
4. The remaining probe section will be steam cleaned.

5. The probe will be reassembled using Teflon pipe tape to ensure gas-tight seals on all connections.
6. The entire soil gas sampling train will be reassembled and purged with nitrogen for at least 30 seconds to remove any residual soil vapor.

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6.0 SAMPLE HANDLING AND ANALYSIS

6.1 Sample Preparation, Handling, and Shipment

ARDL and Pace, the laboratories selected by the Lenz Oil Site Settling Respondents, will supply all appropriate sample containers and shipping containers for the analytical samples. ARDL will supply sample bottles for soil, sediment, surface water, and ground water analytical samples. They will also supply the sample bottles for TOC analysis of the subsurface soil. The bottles will be purchased by ARDL from either I-Chem Research in Hayward, California or Scientific Specialists in Randallstown, Maryland. Either vendor shall prepare containers per the USEPA document "Guidelines for the Preparation of Contaminant-Free Sample Containers" (April 1990 revision). The verification criteria contained therein shall be followed, and the vendor shall provide a certified analysis for each sample container lot supplied. Pace Laboratories, Inc. will provide the activated carbon tubes used for soil gas sampling. The tubes will be supplied to Pace by SKC, Inc. The sample containers for particle size analysis will consist of new, wide-mouth, quart mason jars purchased by ERM from a local variety store. Fox Drilling, Inc. will provide the sample containers for the total porosity samples. These containers consist of standard, commercially available, brass liners for split-spoon samplers.

The analytical and geotechnical samples will be identified as described in Section 4.0 and handled as specified in Table 6-1. All of the sample containers will be filled to a 90 percent capacity except for the volatile organic, TOC, and total porosity sample containers, which must be completely filled and have no headspace. Ground water samples to be analyzed for TAL dissolved

metals will be field filtered through disposable 45-micron filters. Ground water and surface meter samples to be analyzed for TAL total metals will not be filtered. Nitric acid will be added to all metal samples until the pH is less than 2. Ground water and surface water samples to be analyzed for TAL cyanide will be preserved with sodium hydroxide (NaOH) until the pH is greater than 12. If residual chlorine is suspected in the cyanide samples, 1.2 grams of ascorbic acid will be added.

Chain-of-custody procedures will be adhered to in both the field and laboratory. Shipping containers will be accompanied with chain-of-custody papers that identify the date of sample collection, special handling requirements, and the analysis to be performed. Detailed information concerning custody procedures is contained in Section 5.0 of the Quality Assurance Project Plan.

Following filtering and sample preservation, the exterior of the sample containers will be decontaminated, the sample paperwork will be completed, the caps will be securely tightened, and the sample tags and labels will be attached to the sample containers. Each container will be placed in a Ziploc plastic bag, ensuring that labels can be read. Based on existing data, all samples collected from the site are expected to be low concentration samples and should not require special shipping containers.

Samples will be placed in a cooler, and vermiculite or equivalent absorbent material will be packed around the samples to minimize the possibility of container breakage. The temperature will be maintained at 4°C with cold packs or ice, and sealed in plastic bags. The remaining space in the cooler will be filled with additional packing material. Chain-of-custody forms and any other shipping/sample documentation accompanying the shipment will be

enclosed in a Ziploc plastic bag and taped to the inside of the cooler lid. The cooler should be closed and sealed with strapping tape. If the cooler has a drain port, it should be taped shut. Coolers must be sealed with custody seals in such a manner that the custody seal would be broken if the cooler were opened. The custody seals should then be covered with clear plastic tape. Airbills should be affixed with the shipper's and consignee's addresses to the top of the cooler. The samples will be shipped by overnight carrier to ARDL, ATEC, or Pace Laboratories for analysis. The receiving laboratory will be notified upon shipment.

Wastes generated on site will be properly handled and disposed of to prevent contamination of clean areas and to comply with existing regulations. If soil encountered during borehole drilling is expected to be hazardous because of abnormal discoloration, odor or air monitoring levels, the soil cuttings will be containerized in a new, unused drum. Similarly, materials generated during decontamination procedures, such as personal protective equipment, wash water, and soil materials, will be disposed of in drums. Monitoring well development water and purge water will also be collected in new drums. All of the drummed materials will be labeled with: (1) a drum number, (2) the contents of the drum, and (3) the date the drum was filled. An inventory of the drummed materials will be maintained by ERM. All of the drummed materials will be stored in a designated secured drum storage area. The area will be underlain by an impermeable synthetic liner with a gravel cover, fenced, and have a locking gate.

To the extent possible, the drummed waste will be disposed of or remediated as part of the site remedy. However, if disposal of the drummed materials is required before site remediation, composite samples will be collected from drummed materials and tested by the

Toxic Characteristics Leaching Procedures (TCLP) to determine if the cuttings should be disposed of as a hazardous waste. The drummed materials will be disposed of or remediated accordingly.

6.2 Sample Analysis

All samples to be analyzed for TCL organics and TAL inorganics are expected to be low concentration samples and will be analyzed in a manner consistent with RAS CLP procedures. The complete list of CLP TCL and TAL parameters along with their Contract Required Quantitation Limits is presented in Table 1-1 of the Quality Assurance Project Plan (QAPP). TICs will be included in the CLP RAS volatile and semivolatile organic analyses. The CLP TCL and TAL analyses will be conducted by ARDL Laboratories using the RAS methods specified in the 2/88 SOW for organics and the 7/88 SOW for inorganics. However, if a more current version of the CLP RAS SOWs is in effect at the time of sample analysis, ADRL will follow the updated procedures.

Selected soil samples will also be analyzed for TCLP metals by ARDL using the TCLP extraction method and CLP RAS SOW methods for analysis of the metals. Table 1-2 of the QAPP presents the TCLP target parameters and quantitation limits. Soil gas samples will be analyzed for selected volatile organic compounds by PACE Laboratories, Inc. using non-CLP methods. The soil gas target parameters and associated detection limits are presented in QAPP Table 1-3. Additional information regarding sample analysis is presented in QAPP Sections 1.2, 2.3, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, and 13.0.

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TABLE 3-1

SUMMARY OF SOURCE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM

Sample Matrix	Field Parameter	Laboratory Parameter	QA Samples												Matrix Total
			Investigative Samples			Duplicate			Field Blank (Rinsate)			MS/MSD (1)			
			No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	
On-Site Soil Samples	Semiquantitative Organic Vapor Screening with HNu	TCL Volatile Organics	44	1	44	5	1	5	5	1	5	3	1	3	54
		TCL Semivolatiles	44	1	44	5	1	5	5	1	5	3	1	3	54
	Qualitative Description of Soil	TCL PCBs/Pesticides	44	1	44	5	1	5	5	1	5	3	1	3	54
		TAL Total Metals	57	1	57	6	1	6	6	1	6	0	0	0	69
		TCLP Metals	18	1	18	2	1	2	0*	1	0	0	0	0	20
		TAL Cyanide	57	1	57	6	1	6	6	1	6	0	0	0	69

Notes:

- (1) MS/MSD samples are required for organic analyses of soil samples at a frequency of one per group of 20 or fewer investigative samples. No extra sample volume is required for MS/MSD analysis of soil samples.

*TCLP is only analyzed for soil samples.

TABLE 3-2
(PAGE 1 OF 2)
SUMMARY OF SITE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM

Sample Matrix	Field Parameter	Laboratory Parameter	QA Samples												
			Investigative Samples			Duplicate			Field Blank (Rinsate)			MS/MSD (3)			Matrix Total
			No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	
Off-Site Soil Samples	-Qualitative Description of Soil	TCL Volatile Organics	12 ¹	1	12	2	1	2	1	1	1	1	1	1	15
		TCL Semivolatiles	12	1	12	2	1	2	1	1	1	1	1	1	15
	-Qualitative Organic Vapor Screening with HNu	TCL PCBs/Pesticides	12	1	12	2	1	2	1	1	1	1	1	1	15
		TAL Total Metals	12	1	12	2	1	2	1	1	1	0	0	0	15
		TAL Cyanide	12	1	12	2	1	2	1	1	1	0	0	0	15
Sediment Samples	-Qualitative Description of Sediment	TCL Volatile Organics	6	1	6	1	1	1	1	1	1	1	1	1	8
		TCL Semivolatiles	6	1	6	1	1	1	1	1	1	1	1	1	8
	-Qualitative Organic Vapor Screening with HNu	TCL PCBs/Pesticides	6	1	6	1	1	1	1	1	1	1	1	1	8
		TAL Total Metals	6	1	6	1	1	1	1	1	1	0	0	0	8
		TAL Cyanide	6	1	6	1	1	1	1	1	1	0	0	0	8
Soil Gas Samples	-Semiquantitative Organic Vapor Screening with HNu	Selected TCL Volatile Organics ⁽¹⁾	32	1	32	4	1	4	4	1	4	2	1	2	40
Ground Water Samples From Monitoring Wells	-pH	TCL Volatile Organics	23	1	23	3	1	3	3	1	3	2	1	2	29
	-Specific Conductivity	TCL Semivolatiles	23	1	23	3	1	3	3	1	3	2	1	2	29
	-Temperature	TCL PCBs/Pesticides	23	1	23	3	1	3	3	1	3	2	1	2	29
	-Hydraulic Conductivity	TAL Dissolved Metals ⁽²⁾	23	1	23	3	1	3	3	1	3	0	0	0	29
	-Water Level	TAL Cyanide	23	1	23	3	1	3	3	1	3	0	0	0	29
	Qualitative Description of Water	TAL Total Metals ⁽²⁾	23	1	23	3	1	3	3	1	3	0	0	0	29
	-Qualitative Organic Vapor Screening with HNu														

Notes:

- (1) Samples will be analyzed for 1,2-dichloroethane, 1,2-dichloroethene, trichloroethene, 1,1,1-trichloroethane, toluene and xylene.
- (2) Water samples analyzed for TAL dissolved metals will be field-filtered prior to sample preservation. Total metals samples will not be field filtered.
- (3) MS/MSD samples are required for organic analyses of water and soil samples at a frequency of one per group of 20 or fewer investigative samples. Water samples designated for MS/MSD analysis will be collected with extra sample volume.
- (4) One trip blank sample consisting of two 40-ml glass vials filled with organic-free deionized water will be included with each shipment of aqueous samples targeted for volatile organic analysis.

TABLE 3-2
(PAGE 2 OF 2)
SUMMARY OF SITE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM

Sample Matrix	Field Parameter	Laboratory Parameter	(4) QA Samples												Matrix Total
			Investigative Samples			Duplicate			Field Blank (Rinsate)			MS/MSD			
			No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	
Surface Water Samples	-pH	TCL Volatile Organics	6	1	6	1	1	1	1	1	1	1	1	1	8
	-Specific Conductivity	TCL Semivolatiles	6	1	6	1	1	1	1	1	1	1	1	1	8
	-Temperature	TCL PCBs/Pesticides	6	1	6	1	1	1	1	1	1	1	1	1	8
	-Qualitative Description of Water	TAL Total Metals (2)	6	1	6	1	1	1	1	1	1	0	0	0	8
		TAL Cyanide	6	1	6	1	1	1	1	1	1	0	0	0	8
Geotechnical Soil Samples	-Qualitative Organic of Soil	Particle Size Analysis	14	1	14	2	1	2	0	0	0	0	0	0	16
		Total Porosity	14	1	14	2	1	2	0	0	0	0	0	0	16
	-Qualitative Organic Vapor Screening with HNu	Total Organic Carbon	14	1	14	2	1	2	0	0	0	0	0	0	16

Notes:

- (1) Samples will be analyzed for 1,2-dichloroethane, 1,2-dichloroethene, trichloroethene, 1,1,1-trichloroethane, toluene, and xylene.
- (2) Water samples analyzed for TAL dissolved metals will be field filtered prior to sample preservation. Total metals samples will not be field filtered.
- (3) MS/MSD samples are required for organic analyses of water and soil samples at a frequency of one per group of 20 or fewer investigative samples. Water samples designated for MS/MSD analysis will be collected with extra sample volume.
- (4) One trip blank sample consisting of two 40-ml glass vials filled with organic-free deionized water will be included with each shipment of aqueous samples targeted for volatile organic analysis.

TABLE 3-3
(Page 1 of 3)
ANALYSIS OF ON-SITE SUBSURFACE SOIL SAMPLES

ANALYTICAL PARAMETERS							
Soil Boring No.	Sample Depth (Ft. Below Surface)	TCLP Metals	TAL Metals & Cyanide	TCL VOCs	TCL Semivolatile Organics	TCL PCBs & Pesticides	Remarks
SB01	0-5 5-bedrock		X X	X X	X X	X X	NOTE 1
SB02	0-5 5-bedrock		X X	X X	X X	X X	NOTE 1
SB03	0-5 5-bedrock		X X	X X	X X	X X	NOTE 1
SB04	0-2.5 2.5-5	X X	X X				NOTE 2
SB05	2.5 0-5 5-9	X X	X X	X	X	X	NOTE 3
SB06	2.5 0-5 5-9	X X	X X	X	X	X	NOTE 3
SB07	2.5 0-5 5-9	X X	X X	X	X	X	NOTE 3
SB08	0-2.5 2.5-5	X X	X X				NOTE 2
SB09	2.5 0-5 5-9	X X	X X	X	X	X	NOTE 3
SB10	0-2.5 2.5-5	X X	X X				NOTE 2
SB11	0-2.5 2.5-5	X X	X X				NOTE 2
SB12	2.5 0-5 5-9	X X	X X	X	X	X	NOTE 3
SB13	0-5 5-9 9-bedrock		X X X	X X X	X X X	X X X	NOTE 4

TABLE 3-3
(Page 2 of 3)
ANALYSIS OF ON-SITE SUBSURFACE SOIL SAMPLES

ANALYTICAL PARAMETERS							
Soil Boring No.	Sample Depth (Ft. Below Surface)	TCLP Metals	TAL Metals & Cyanide	TCL VOCs	TCL Semivolatile Organics	TCL PCBs & Pesticides	Remarks
SB14	0-5 5-9 9-bedrock		X X X	X X X	X X X	X X X	NOTE 4
SB15	0-5 5-9 9-bedrock		X X X	X X X	X X X	X X X	NOTE 4
SB16	0-5 5-9 9-bedrock		X X X	X X X	X X X	X X X	NOTE 4
SB17	0-5 5-9 9-bedrock		X X X	X X X	X X X	X X X	NOTE 4
SB18	0-5 5-9 9-bedrock		X X X	X X X	X X X	X X X	NOTE 4
SB19	0-5 5-9 9-bedrock		X X X	X X X	X X X	X X X	NOTE 4
SB20	0-5 5-9 0-bedrock		X X X	X X X	X X X	X X X	NOTE 4
SB21	0-5 5-9 9-bedrock		X X X	X X X	X X X	X X X	NOTE 4
SB22	0-5 5-9 9-bedrock		X X X	X X X	X X X	X X X	NOTE 4
SB23	0-5 5-9 9-bedrock		X X X	X X X	X X X	X X X	NOTE 4

TABLE 3-3
(Page 3 of 3)
ANALYSIS OF ON-SITE SUBSURFACE SOIL SAMPLES

NOTES

NOTE 1: Samples will be collected from 2.5-foot intervals of soil exhibiting the highest HNu reading in each depth zone (i.e., 0-5 feet and 5 feet to bedrock). If no HNu readings above background are detected, samples will be collected from the 2.5- to 5.0-foot interval and the 2.5-foot interval immediately above bedrock.

NOTE 2: Samples will be collected from both the 0- to 2.5-foot and 2.5- to 5.0-foot intervals, regardless of HNu readings.

NOTE 3: Shallow samples will all be collected from the 2.5- to 5.0-foot interval, regardless of HNu readings. Deep samples will be collected from the 2.5-foot interval of soil exhibiting the highest HNu reading between 5 and 9 feet. If no HNu readings above background are detected, HNu samples will be collected from the 7.0- to 9.0-foot interval.

NOTE 4: Samples will be collected from 2.5-foot intervals of soil exhibiting the highest HNu reading in each depth zone (i.e., 0-5 feet, 5-9 feet and 9 feet-bedrock). If no HNu readings above background are detected, samples will be collected from the 2.5- to 5.0-foot interval, 7.0- to 9.0-foot interval, and the 2.5-foot interval immediately above bedrock.

TABLE 5-1
UNIFIED SOIL CLASSIFICATION SYSTEM

Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)				Group Symbol	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria		
Coarse-grained soils More than half of material is larger than No. 200 sieve size ^b (The No. 200 sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than No. 7 sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils, add information on stratification, degree of compaction, cementation, moisture conditions and drainage characteristics Example: Silty sand, gravelly, about 20% hard, angular gravel particles 1/2-in. maximum size, rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM)	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for GW Atterberg limits below "A" line, or PI less than 4 Atterberg limits above "A" line, with PI greater than 7 Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols		
			Predominantly one size or a range of sizes with some intermediate sizes missing	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines				
			Nonplastic fines (for identification procedures see <i>ML</i> below)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures				
	Gravels with fines (appreciable amount of fines)	Clean sands (little or no fines)	Plastic fines (for identification procedures, see <i>CL</i> below)	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures				
			Wide range in grain sizes and substantial amounts of all intermediate particle sizes	SW	Well graded sands, gravelly sands, little or no fines				
			Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Poorly graded sands, gravelly sands, little or no fines				
Fine-grained soils More than half of material is smaller than No. 200 sieve size ^b (The No. 200 sieve size is about the smallest particle visible to naked eye)	Sands with fines (appreciable amount of fines)	Clean sands (little or no fines)	Nonplastic fines (for identification procedures, see <i>ML</i> below)	SM	Silty sands, poorly graded sand-silt mixtures	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: Clayey silt, brown, slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (<i>ML</i>)	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for SW Atterberg limits below "A" line or PI less than 5 Atterberg limits below "A" line with PI greater than 7 Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols		
			Plastic fines (for identification procedures, see <i>CL</i> below)	SC	Clayey sands, poorly graded sand-clay mixtures				
		Identification Procedures on Fraction Smaller than No. 40 Sieve Size							
		Sands and clays liquid limit less than 50	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				
			None to slight	Quick to slow	None			<i>ML</i>	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
			Medium to high	None to very slow	Medium			<i>CL</i>	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	Slight to medium		Slow	Slight	<i>OL</i>			Organic silts and organic silt-clays of low plasticity	
	Slight to medium		Slow to none	Slight to medium	<i>MH</i>			Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
	High to very high		None	High	<i>CH</i>			Inorganic clays of high plasticity, fat clays	
	Silt and clays liquid limit greater than 50	Medium to high	None to very slow	Slight to medium	<i>OH</i>			Organic clays of medium to high plasticity	
		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			<i>PI</i>			Peat and other highly organic soils	

Determine percentages of gravel and sand from grain size curve
Depending on percentages of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows
GW, GP, SW, SP
More than 5%
More than 12%
5% to 12%
Borderline cases requiring use of dual symbols

Use grain size curve in identifying the fractions as given under field identification

Plasticity index

Comparing soils at equal liquid limit

Liquid limit

Plasticity chart for laboratory classification of fine grained soils

From Wagner, 1957.

^a Boundary classifications. Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.

^b All sieve sizes on this chart are U.S. standard.

Field Identification Procedure for Fine Grained Soils or Fractions

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/4 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking):

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics):

After removing particles larger than No. 40 sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit):

After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: GW, GP, SW, SP, GM, GC, SM, SC. Borderline cases requiring use of dual symbols.

Use grain size curve in identifying the fractions as given under field identification.

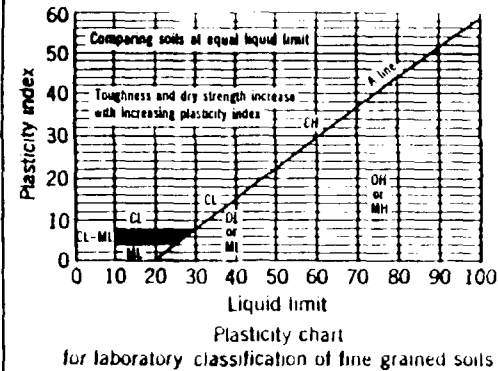


TABLE 6-1
(Page 1 of 2)

SAMPLING HANDLING INFORMATION

<u>PARAMETER</u>	<u>CONTAINER(4)</u>	<u>PRESERVATIVE</u>	<u>REQUIREMENTS (Holding Time and Volume Requirements)</u>
<u>Ground Water, Surface Water, and Rinsate Samples(1)</u>			
TCL volatile organics	2 x 40 ml glass vials with Teflon-lined septum	Iced to 4 ⁰ C	Analysis within 7 holding days, no headspace
TCL semivolatile organics	3 x 1 liter amber glass bottles with Teflon-lined cap	Iced to 4 ⁰ C	5 days until extraction, analysis within 40 days after extraction, fill to shoulder
PCBs, Pesticides	2 x 1 liter amber glass bottles with Teflon-lined cap	Iced to 4 ⁰ C	5 days until extraction, analysis within 40 days after extraction, fill to shoulder
TAL Dissolved Metals	1 x 1 liter glass bottles with Teflon high density polyethylene bottle	Filter through 0.45 um filter, nitric acid to pH ≤2, iced to 4 ⁰ C	6 months except for Hg which is 26 days, fill to shoulder
TAL Total Metals	1 x 1 liter high density polyethylene bottle	Nitric Acid to pH - 2, iced to 4 ⁰ C	6 months except for Hg which is 26 days, fill to shoulder
TAL Cyanide	1 x 1 liter clear glass bottle with Teflon-lined cap	Iced to 4 ⁰ C, NAOH to pH > 12 1.2 gm Ascorbic Acid if chlorine is suspected	Analysis within 14 days, fill to shoulder
<u>Soil Gas Samples(2)</u>			
Target Volatile Organics	Activated carbon cartridge packaged in 500 ml, wide-mouth glass bottles	Iced to 4 ⁰ C	Analysis within 14 days, cap cartridge ends
<u>Soil/Sediment Samples(1)</u>			
TCL volatile organics	2 x 4 oz, wide-mouth glass jars with Teflon-lined cap	Iced to 4 ⁰ C	Analysis within 10 days, tightly packed, no headspace
TCL semivolatile organics	1 x 1 liter, wide-mouth amber glass jar with Teflon-lined cap	Iced to 4 ⁰ C	Analysis within 10 days, fill jar at least 3/4 full
PCBs/Pesticides	From semivolatile organic container	Iced to 4 ⁰ C	Analysis within 10 days

TABLE 6-1
(Page 2 of 2)

SAMPLING HANDLING INFORMATION
(continued)

<u>PARAMETER</u>	<u>CONTAINER(4)</u>	<u>PRESERVATIVE</u>	<u>REQUIREMENTS (Holding Time and Volume Requirements)</u>
TAL Metals	1 x 8 oz, wide-mouth glass jar with Teflon-lined lid	Iced to 4°C	Analysis within 6 months, fill jar at least 3/4 full
TAL Cyanide	From TAL Metals container	Iced to 4°C	Analysis within 14 days, fill jar at least 3/4 full
TCLP Metals	2 x 1 liter amber, wide-mouth glass jar with Teflon-lined lid	None	Extraction within 28 days, except for Hg which is 180 days; analysis within 28 days after extraction, except for Hg which is 180 days after extraction; fill completely
<u>GEOTECHNICAL SAMPLES(3)</u>			
Particle Size Analysis	1 x 1 quart clear, wide-mouth glass Mason jar	None	No holding time requirements; fill jar at least 3/4 full.
Total Porosity	1-2.5" x 6" Brass sleeve with plastic caps or paraffin seal	None	No holding time requirements; brass sleeve must be full and soil must be undisturbed.
Total Organic Carbon	1 x 4oz., wide-mouth glass jars with Teflon-lined cap	Iced to 4°C	Analysis within 14 days; tightly packed; no head space.

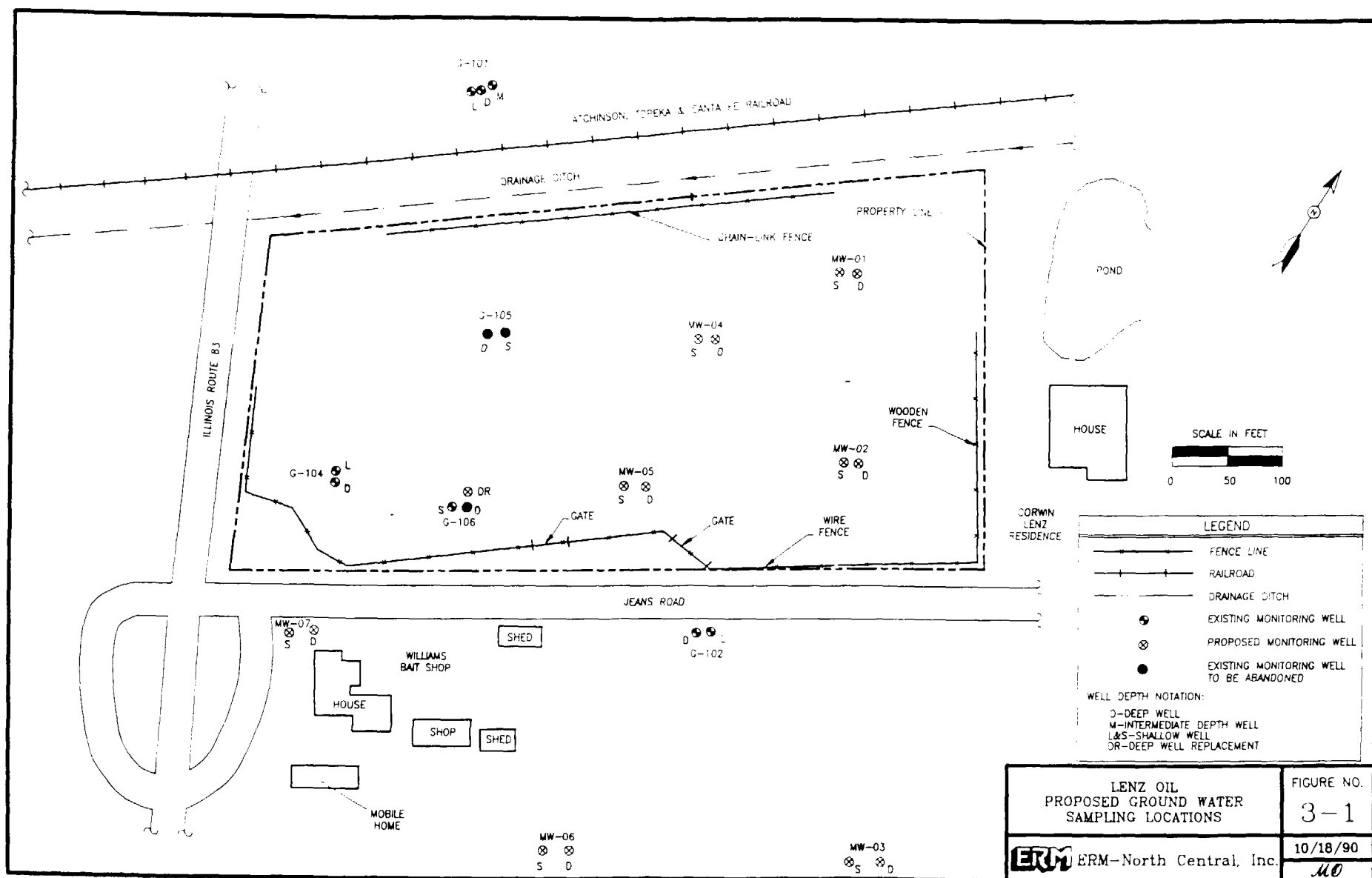
Notes:

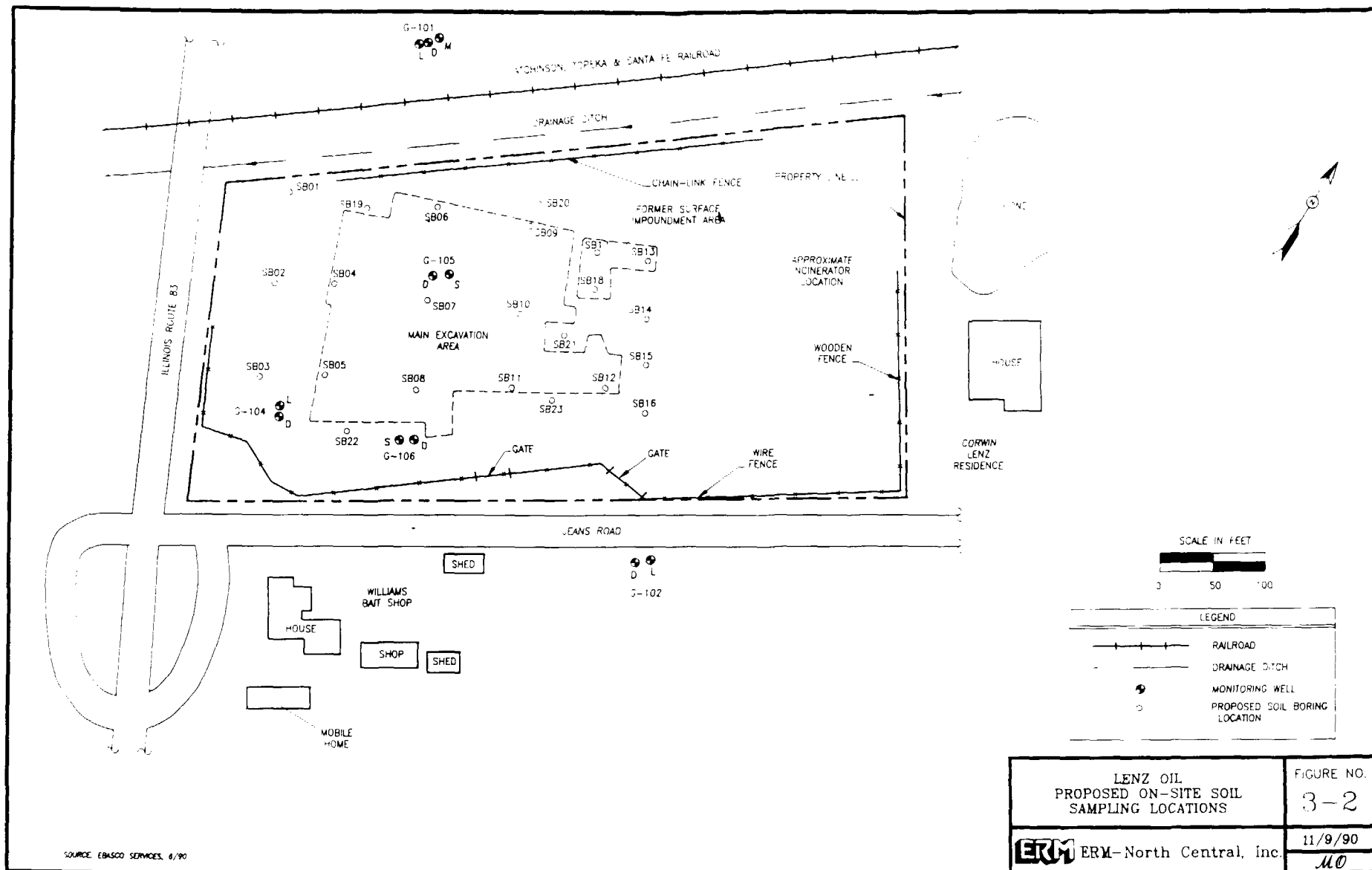
- (1) Ground water and soil parameters to be analyzed by ARDL Laboratories.
- (2) Soil gas parameters to be analyzed by Pace Laboratories.
- (3) Geotechnical parameters to be analyzed by ATEC and Associates, Inc.
- (4) Water samples designated for MS/MSD analysis will be collected with extra sample volume for the VOC, and SVOC fractions.

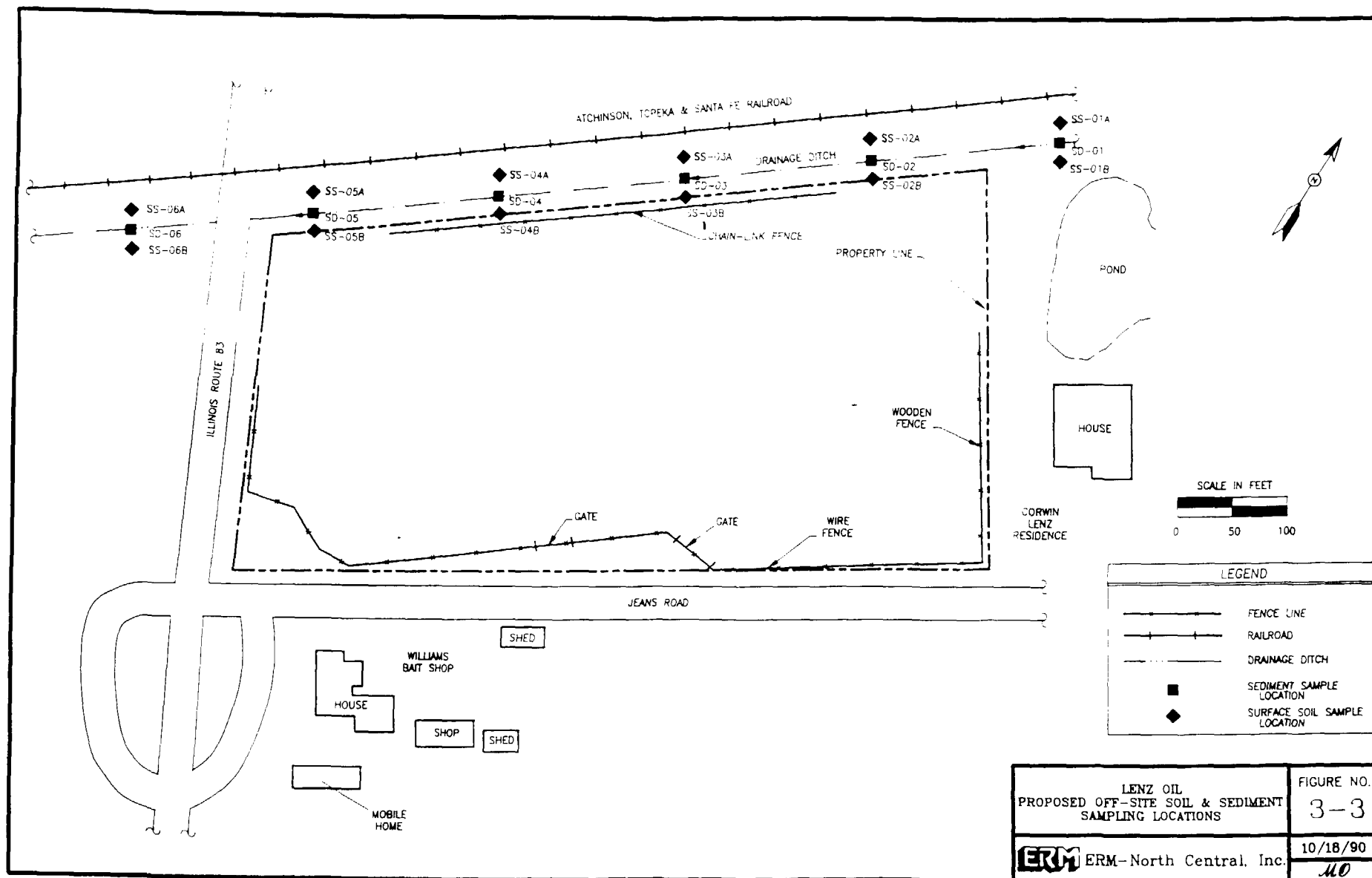
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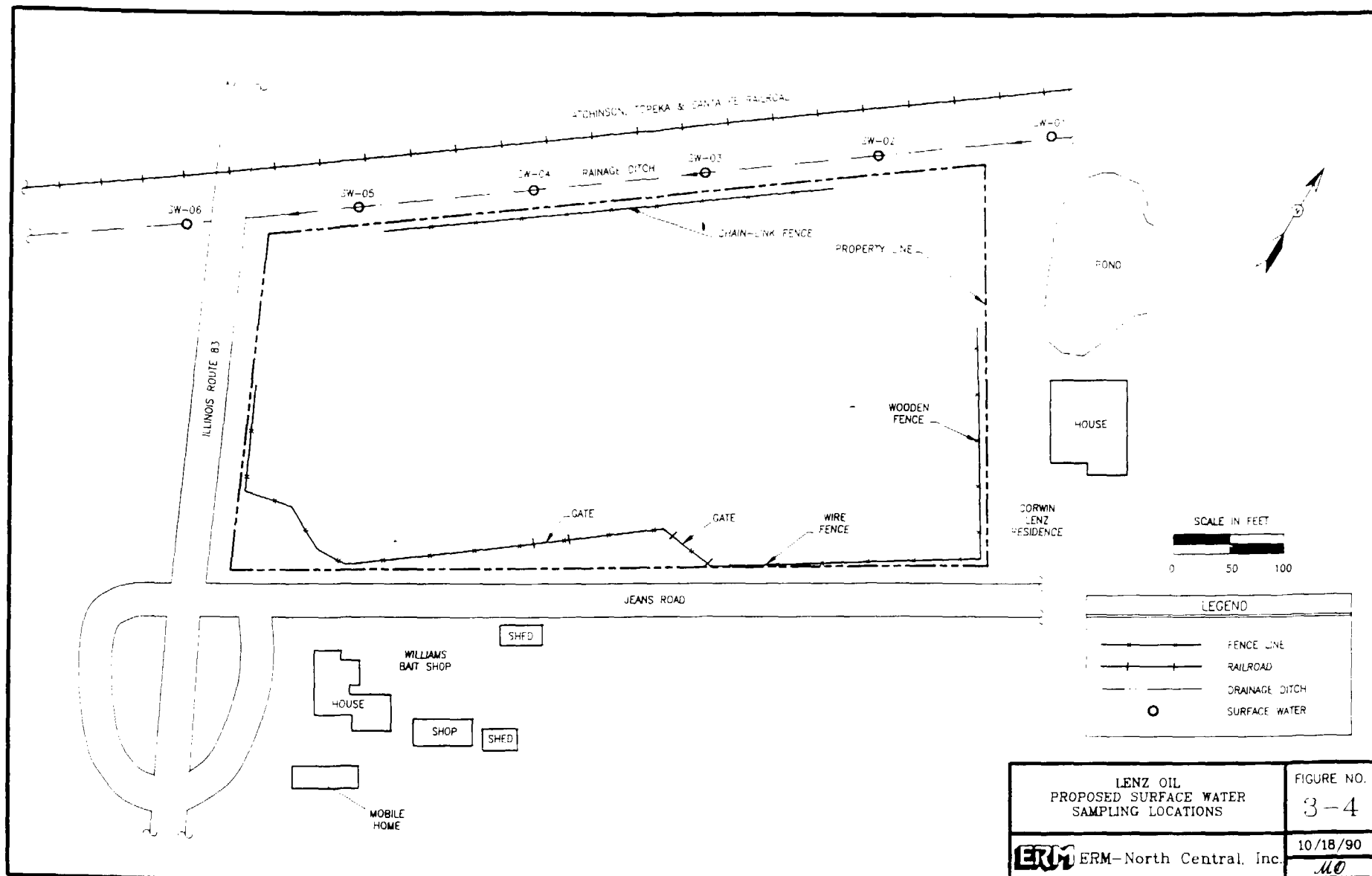
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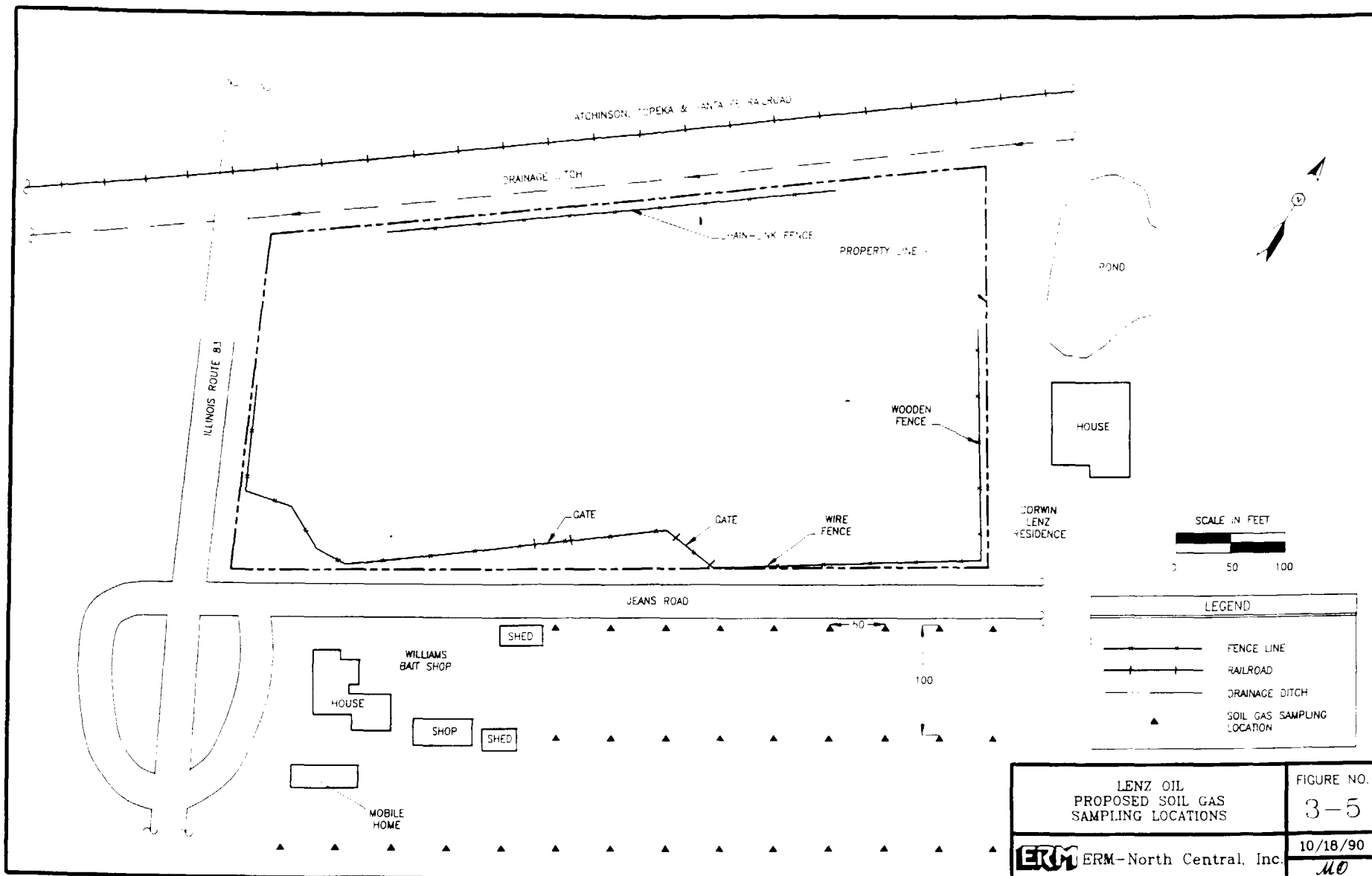
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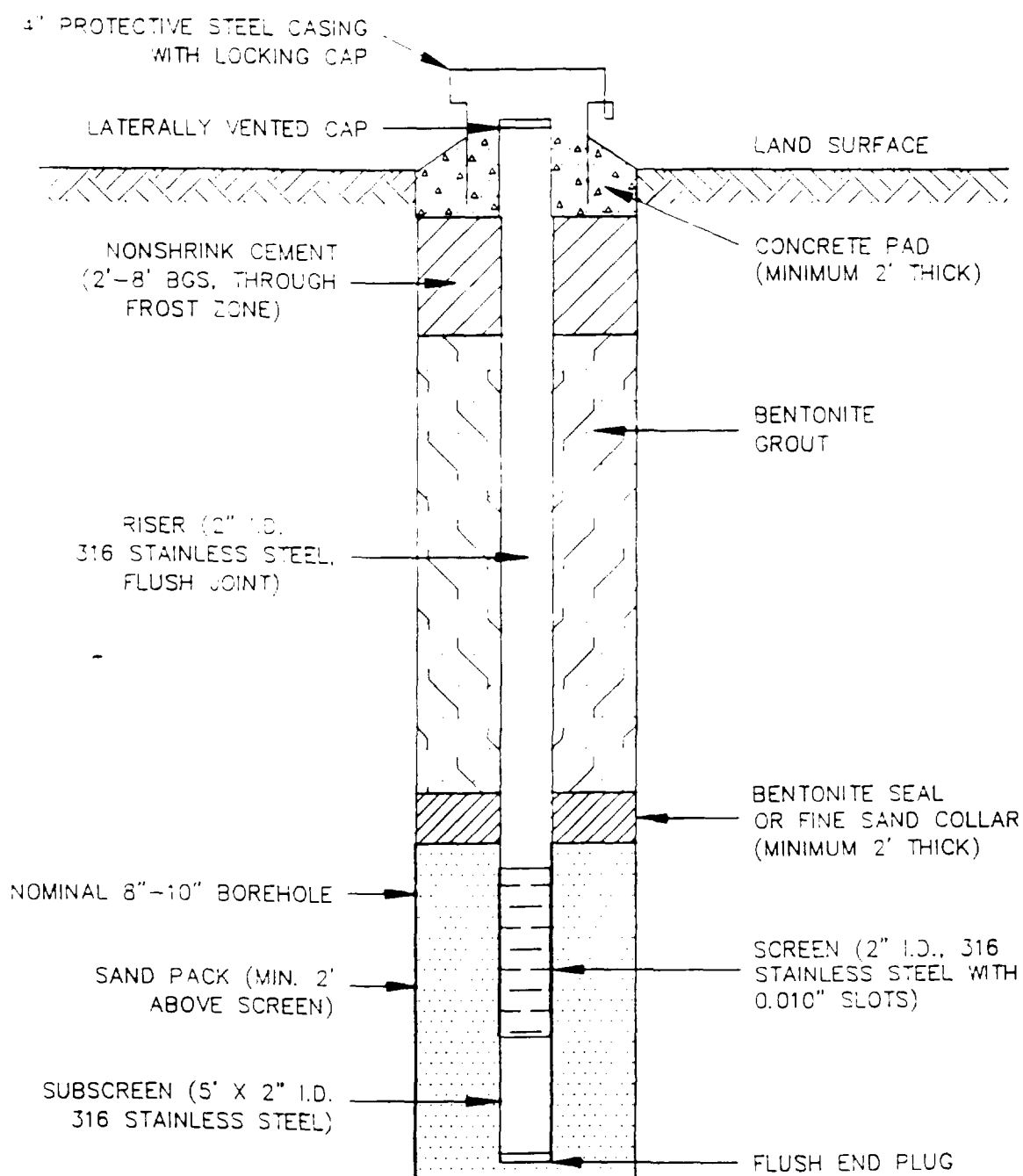












NOT TO SCALE

MONITORING WELL
CONSTRUCTION DETAILS

FIGURE
5-1



ERM-North Central, Inc.

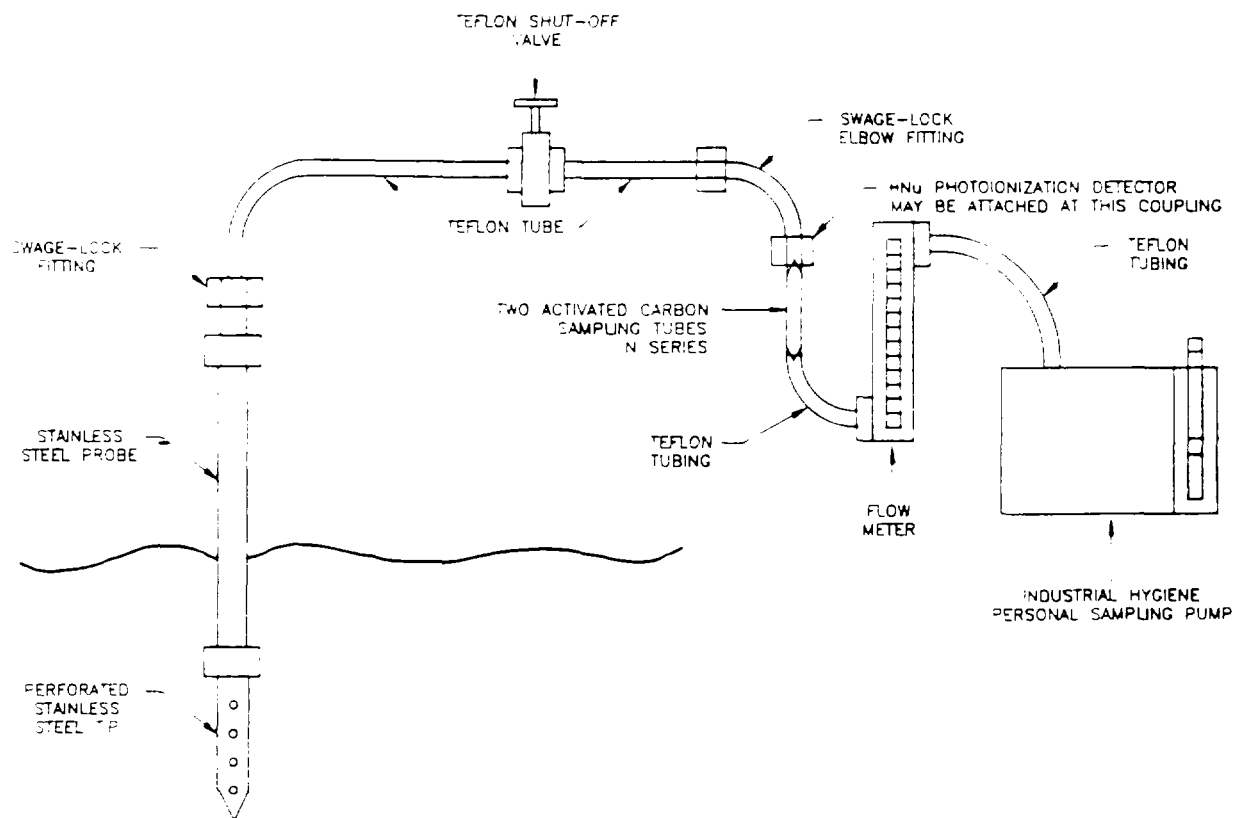
Dearfield, IL 60015

(708) 948-7800

9292

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SCHEMATIC DIAGRAM OF
SOIL GAS SAMPLING TRAIN

FIGURE
5-2



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